FEDERATED SOCIAL NETWORKING SITES AS A TOOL FOR eLEARNING: A CASE OF MIDLANDS STATE UNIVERSITY IN ZIMBABWE

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ABSTRACT

The literature shows a surge in social networking sites, users of social networking sites, the frequency of visits to social networking sites and the time spent on each visit. This calls for a paradigm shift from asynchronous to synchronous means of communication. Asynchronous communication is being used worldwide, particularly for online lectures, business meetings, business launches or mere communication. However, some of the literature has expressed concerns about the challenges of the effect of social networking sites on students, including time spent on social networking sites for non-academic purposes, which may negatively affect their academic performance. Even though it would be futile to explore detaching the upcoming generation from social networking sites, capitalising on such a challenge is certainly a research opportunity.

Accordingly, this study suggests an appropriate and effective solution by proposing the federation of social networking sites as an eLearning tool in universities. This is accomplished by recommending a framework that leverages existing social networking sites' capabilities by aggregating communication channels to facilitate eLearning. Even though there are many eLearning frameworks in the literature, including some federated eLearning frameworks, this study specifically investigates the cutting-edge social networking sites that are increasingly used seamlessly as mobile applications and, therefore, need to be embedded in eLearning systems to achieve their added benefits.

Research objectives and questions were formulated to assess the typology of social networking sites on the one hand and the extant eLearning frameworks and their contributions to the educational system on the other to achieve the main purpose of this study. The analysis of the outcome of findings from research questions linked to the foregoing objectives paved the way for the development of three different types of federated frameworks as eLearning tools in higher and tertiary educational institutions, these were further developed into a conceptual framework, a hybrid federated social networking sites for eLearning (HFSNS4eL).

Our proposed conceptual hybrid framework was considered for further evaluation by key stakeholders in the eLearning value chain. To this end, an intensive survey was conducted and

data collected from participants in the survey were analysed quantitatively and qualitatively, resulting in some improvement of the framework. The study contributes not only to the body of knowledge on information systems and applications to social networking in general but has provided a solution to problems associated with SNSs use in higher educational institutions, an HFSNS4eL and the use of cheaper means of data communications in education.

Keywords: social networks, social networking, social networking sites, integration of social networking sites, federation of social networking sites, e-Learning, e-Learning frameworks, e-Learning models, education systems

DECLARATION

Name: Beauty Mugoniwa

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Degree: Doctoral degree in Information Systems

I declare that the **Federated social networking sites as a tool for eLearning: a case of Midlands State University in Zimbabwe** is my own work and that all the sources I have used or quoted have been indicated and acknowledged by means of complete references. I further declare that I have not previously submitted this work, or part of it, for examination at Unisa for another qualification or at any other higher education institution.

_____ B. Mugoniwa _____ __27/11/23_____

SIGNATURE DATE

ACKNOWLEDGEMENTS

I want to take this opportunity to show my sincere gratitude to all those who contributed to this doctoral study becoming a reality.

Before mentioning any names, I want to give thanks, honour and praise to the Almighty God for His existence in my life, which is the pillar of my existence. He gave me the strength to endure the long, demanding and depressing, although gratifying duration of this academic journey. All I want is to say thank you, Lord, in Jesus' name, Amen!

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DEDICATION

This thesis is dedicated to my family (husband and children), mother and sister (Mary) for praying for me all the time; their encouragement and motivation contributed towards the completion of this study.

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ACRONYMS/ ABBREVIATIONS

SNSs	Social networking sites
DS	Design Science
IS	Information systems
MSU	Midlands State University
FSNS	Federated Social Networking Site
SPSS	Statistical Package for Social Sciences
ERC	Ethics Review Committee
UNISA	University of South Africa
KMO	Kaiser-Meyer-Olkin
KM	Knowledge Management
HTTP	Hypertext Transfer Protocol
TCP	Transmission control protocol
RSS	Really Simple Syndication
GPG	GNU Privacy Guard
XMPP	Extensible Messaging and Presence Protocol
PEP	Personal Eventing Protocol
P2P	Peer to peer
DOSN	Decentralised Online Social Networks
PrPl	Private Public
LAMP	Linux, Apache Server, MySQL
PHP	Hypertext Preprocessor
Linux	Lovable Intellect Not Using XP
MySQL	My Structured Query Language

SMC	Service Management Console
PSN	Professional Social Network
CEO	Chief Executive Officer
VP	Vice President
B2B	business-to-business
US	United States
Inc.	Incorporated
ROI	Return on investments
PDF	Portable Document Format
GB	GigaBytes
API	Application Programming Interface
JMS	Java Messaging Service
DB	DataBase
JSP	JavaServer Pages
SMTP	Simple Mail Transfer Protocol
EDU	Education
ID	Identity
DNS	Domain Name System
HTML	HyperText Markup Language
URL	Uniform Resource Locator
RT	Retweet
GUI	Graphical User Interface
CSS	Cascading Style Sheets
XML	Extensible Markup Language
DIY	Do it yourself

RDF	Resource Description Framework
SPARQL	SPARQL Protocol and RDF Query Language
ICT	Information Communication and Technology
TV	Television
CDROM	Compact Disk Read Only Memory
SMS	Short Message Service
GPRS	General Pocket Radio Services
MMS	Multimedia Mail Service
WAP	Wireless Application Protocol
IT	Information Technology
SSCL	Social Network to Support Collaborative Learning
CoP	Communities of Practice
(CoI)	Communities of Inquiries
LMS	Learning Management System
FE	Front End
BE	Back End
IDS	Intrusion Detection Systems
FTP	File Transfer Protocol
FIdP	Federated Identity Provider
IdP	Identity Provider
SAML	Security Assertion Mark-up Language
SSO	Single Sign-On
OAuth	Open Authorisation
OpenID	Open Identification
GPS	Global Positioning System

PO	Primary research Objective
SO	Secondary research Objective
HFSNS	Hybrid Federated Social Networking Sites
KS-test	Kolmogorov-Smirnov test
MNOs	Mobile Networking Operators

LIST OF APPENDICES

LIST OF PUBLICATIONS

1- Mugoniwa, B., Ngassam, E. K. and Singh, S. (2024) 'A Comparative Tale of Peer-to-Peer, Client-to-Server and Hybrid Networks in Federated Social Networking Sites in Educational Institutions', *Indonesian Journal of Information Systems*, 7(1), pp. 13–27.

2- Mugoniwa, B., Ngassam, E. K. and Singh, S. (2023) 'Towards a Hybrid Federated Social Networking Architecture. A Case of Zimbabwe's Higher Education', 2023 IST-Africa Conference, IST-Africa 2023, pp. 1–9. doi: 10.23919/IST-Africa60249.2023.10187749.

3- Mugoniwa, B. and Ngassam, E. K. (2021) 'The readiness for adoption of federated social networking sites to enhance contemporary educational engagement. The case of Zimbabwean universities', in *2021 IST-Africa Conference, IST-Africa 2021*, pp. 1–7.

4- Mugoniwa, B., Ngassam, E. K. and Singh, S. "Towards a Hybrid Federated Social Networking Architecture. A Case of Zimbabwe's Higher and Tertiary Education", (**Under Review**) Submitted to *The African Journal of Information Systems*

Chapter 1 : Introduction

1.1 Introduction

The internet can be beneficial to users in general and students in particular, as much as it can be a potentially detrimental to them. At its inception, the internet was used for the purpose of research, mainly academic research. It was also used as a means for peer communication and information exchange, reading news, viewing movies and online gaming. Recent advancements on the internet have seen the rise of social networking sites (SNSs) (Zanamwe, Rupere, Kufandirimbwa et al., 2013). Social networks have proved to be a faster way of communicating and conveying current news, especially news affecting the lives of people in communities and society at large. There are many instances where news has spread unchecked in social networks, regardless of the source of such news. A particular case in Zimbabwe was the death of the famous Cecil (a lion) on the 2nd of July 2015, which was all over social networks before any (official) news crew had even addressed the story. In addition, many news updates on accidents, health education on disease outbreaks and political activities occur. The internet possesses many benefits associated with it being cheaper communication via email and entertainment such as movie downloads, online games and social networking sites. Since online SNSs are considered personal spaces, they are platforms where users can exhibit their intellect and communication skills. The amount of time users spend on these networking sites is controlled by the activities engaged in by the user and the number of chats per particular login session (Casero-Ripollés, 2022; Eid & Al-Jabri, 2016; Owusu-Acheaw & Larson, 2015; Thapaliya, 2022; Vázquez-Herrero et al., 2022).

In this chapter, we introduce our research towards the development of a framework of federated social networking sites as a tool for eLearning in universities. The chapter specifically explores the historical background leading to the adoption and usage of social networking sites and further elaborates on the motivations building up to the research problem. The foregoing forms the basis for the enunciation of the main purpose of our research, followed by the description of its sub-objectives as well as associated research questions. Furthermore, the chapter describes the research methodology, the significance of the study and its ethical considerations and concludes with the overall chapter layout of the thesis.

1.2 Background of the Study

The number of social networking site users has been steadily increasing over the years, with the statistics of the SNSs users averaging 59.4% of the population as of January 2023. This is further categorised into 46.3% of women and 53.7% of men subscribed to social media.Whilst in Zimbabwe,

the SNSs users accounted for 9.1% of the total population as of January 2023, this total population can be further broken down into 35.6% of 12 years and below, meaning the remaining were above 12 years (Kemp, 2023a). The top SNSs sites visited (ranked according to the most popular) are Facebook, YouTube, WhatsApp, Instagram, WeChat, TikTok, Facebook Messenger, Douyin, Telegram, Snapchat, Kuaishou, Sina Weibo, QQ, Twitter and Pinterest (Kemp, 2023b). In Zimbabwe, the top-ranked SNSs are Facebook, Twitter, Pinterest, YouTube, Instagram, LinkedIn, Reddit, Tumblr, Vkontakte and news.ycombinator.com, respectively. The total number of Facebook users accounted for 8.1% as of January 2023, with 56.4% male and 43.6% female users (NapoleonCat, 2023).

Social networking sites have been increasingly visited by large numbers of users. The number of SNSs has equally increased where each site has a main functionality; some help users to connect with old friends or seek new friends, while others are mainly used for streaming video, advertising, political and research purposes, and professional reasons. The various SNSs differ in the magnitude to which they are accessed; some require passwords simply to access, whereas others grant full access with a password whereby a person has limited privileges without an account. Many of the sites have some privacy features allowing users to control their accounts, meaning they can filter users to decide who can access their accounts and which users they communicate and share their content with by configuring their privacy status to allow only privileged peers to view particular information on their profiles (Cabello, Franco and Alexandra, 2013; Kemp, 2023b).

SNSs are grouped according to their features, with Facebook (Facebook.com), X (Twitter.com, X.com) and MySpace (myspace.com) examples of worldwide popular networks(Zanamwe, Rupere and Kufandirimbwa, 2013), with some social networks such as Flickr, YouTube and Google Video used to share multimedia content, and others such as Live Journal and BlogSpot used to share blogs (Zimuto, 2013). People engage SNSs for various reasons, including to maintain relationships, form new social connections, seek either or both educational and emotional support and entertain themselves. Increasingly more people are using SNSs to research and learn about others, pass the time, strengthen weak ties, search for business contacts and collaborate on research work (Steinfield *et al.*, 2012).

Students visit these platforms as an ecosystem to search for information and interact with peers on academic matters by joining educational networks and looking for career opportunities. This enables students to gain a sense of belonging to an educational environment since they would be meeting their fellow students virtually, who might be the same students they would be meeting on campus during face-to-face learning, implying that even when they are at home, the spirit of learning would still be around since they would feel in proximity to their peers through their SNSs.

These sites are perceived distractors; hence, there is a need for good management, for students to reap their benefits rather than being affected negatively since SNSs can be destructive if not utilised sensibly. Using SNSs ethically and beneficially can help students avoid problems like becoming detached from direct and physical contact or succumbing to using these networking sites for fraudulent purposes.

Despite these negative impacts, social networking on websites is an innovation of social and technological natures that can no more be overlooked in the academic setup. Facebook is a great tool for "…better communication, socialisation, coordination, collaboration and entertainment"(Al-Tarawneh, 2014, p. 204), despite some negative aspects like addiction, weakening physical ties and students spending much time surfing and chatting on the site, thereby leaving less time for academic duties. Facebook and YouTube are very user-friendly with high interactivity due to the way they were developed, which allows even a layperson to use them, i.e., they have a variety of communication tools which are not only easy to use but also instantaneous. This research seeks to build a framework for the adoption of a federation of SNSs as a tool for eLearning in universities to support other researchers who opine that students need guidance on how to strike a balance between their social and academic lives since their social lives are inherently more interesting than academic work. Some researchers reiterate that SNSs have a positive impact on academic endeavours; therefore, it could be advantageous if they are utilised as eLearning tools (Al-Tarawneh, 2014; Balakrishnan et al., 2017; Cabello, Franco & Haché, 2013; Dlamini et al., 2015; Helou, 2014; Mehmood, 2013; Zanamwe, Rupere & Kufandirimbwa, 2013b; Zimuto, 2013).

A study conducted in Malaysia and Australia finds that in Malaysia, social media is used for academic purposes, such as sharing academic materials, while in Australia, users mostly engage in pure social networking (Balakrishnan *et al.*, 2017). The study further reveals that students from both countries agree that these tools are a rich source of knowledge through which information can be shared easily by using discussion platforms and even search tools. In distance learning, these platforms are convenient because they breach the distance barrier between students. It also helps them collaborate and have better discussions; even teamwork with assigned projects becomes possible since group members can view, discuss and compare their work (Ozmen and Atici, 2014; Balakrishnan *et al.*, 2017).

SNSs like Facebook are going to be adopted as eLearning tools, replacing the traditional classroom setup. This prediction motivated the present study to devise how these networking sites can indeed support the eLearning system rather than destroy it. Other learning tools like learning management systems have been used in educational environments and proved useful although they lack the socialising component inherent to SNSs, which appears to be considered trendier. Nevertheless, some authors encourage learning management systems such as *Moodle* embedded with characteristics found in Web 2.0, which, in turn, are features of SNSs. Besides social networking, SNSs are now mostly used by students for information and knowledge sharing, compared to traditional learning systems. SNS platforms enable flexible communication, leading to enriched information discovery and dissemination. Students discuss, collaborate and debate, and post comments, research material and results, which allows for attaining problem-solving skills, the opportunity to widen knowledge content and boosting students' confidence (Khan & Tahir Bakhsh, 2015; Pilli, 2014, p. 94).

1.3 Problem Statement

Given that almost everyone using the internet is subscribed to at least one, and often many, online social networks, it is unsurprising that social networks have impacted how people live and socialise (Banes, 2008). This has motivated many scholars to study the use of social media in the academic environment, specifically in the areas benefits and challenges of students' SNSs use, SNSs use as eLearning tools in the education sector(Al-Mukhaini, Al-Qayoudhi and Al-Badi, 2014; Al-Tarawneh, 2014; Dlamini, Ncube and Muchemwa, 2015; Ementa and Ile, 2015; Khan and Tahir Bakhsh, 2015; Nkatha, Kimwele and Okeyo, 2015; Van, Underwood and Tai, 2021; Chen and Xiao, 2022; Le, McConney and Maor, 2024). This is because a person using the internet is also likely to be accessing SNSs since people are spending more time on SNSs because of the availability of internet connectivity(Bernard, 2020; Ostic *et al.*, 2021; Chen and Xiao, 2022; Ma, 2022). Extant studies described the time spent by students as, "... most of their time…", "…an ample of their time…", "…a significant amount of time..." and "considerable time", other students go to the extent of "pinging" and "Facebooking" during the course of their lectures (Oguguo *et al.*, 2020; Iqbal *et al.*, 2022; Orji, Eke and Elejere, 2022; Tafesse, 2022; Masalimova *et al.*, 2023). SNSs have become part of the virtual learning environment and since students are into many social activities, the introduction of social networks to their learning systems would make them feel like they are socialising, even when discussing academically related issues.

Students enjoy gathering most of their information from social networks rather than from traditional presentations of information like newspapers and textbooks; even listening to news bulletins has become a problem. This is because they are easy to access, cheaper, their interactivity and ubiquity (Zamri, Zaihan and Samat, 2018; Schwaiger, Vogler and Eisenegger, 2022; Magnusson, 2023). (Olga Pilli, 2014). So having realised that SNSs are accessed and implemented as a means of communication in institutions and that students are one of the most active age groups on SNSs, it is imperative to investigate how students can use these sites to their advantage. In this study, we identified the need to find a concrete solution whereby students would be pursuing academic endeavours within an SNS environment. Therefore, the problem statement for this study is that, *students spend a lot of time on SNSs to socialise to the detriment of their academic work and hence there is the need to develop an SNS tool*[1] *that could be used as a learning management system so whilst the students socialise, they also learn alongside and hence offering a good balance.*

1.4 Research Aim and Objectives

[1] In this study Tool, Framework or Model is used interchangeably because they are regarded as means or a mode used to facilitate eLearning activities through the use of SNSs.

The main research objective (RO) is to develop an FSNS framework to be used as a tool for eLearning at universities.

To attain the stated main RO, the following sub-research objectives have to be achieved:

1.4.1 Sub-Research Objectives (SRO):

Sub-Research Objective 1 (SRO1): *To investigate SNSs and provide their comprehensive characteristics.*

Sub-Research Objective 2 (SRO2): *To explore existing eLearning frameworks to build a strong foundation for the prospective eLearning framework.*

Sub-Research Objective 3 (SRO3): *To develop a conceptual federated social networking site for eLearning (FSNS4eL).*

Sub-Research Objective 4 (SRO4): *To evaluate and validate the proposed conceptual FSNS4eL and then deliver an improved version for further adoption.*

1.5 Research Question

The main research question of this study is formulated as follows:

How can a framework of federated social network sites for eLearning be developed to improve learning through SNSs at universities?

For the study to address this question, the following specific research questions need to be addressed.

1.5.1 Sub-Research Questions (SRQ)

Sub-Research Question 1 (SRQ1): What are the existing SNSs, and what are their characteristics?

Sub-Research Question 2 (SRQ2): What existing eLearning frameworks are found in the literature?

Sub-Research Question 3 (SRQ3): How to use technologies such as models, use cases, flowcharts and architectures to develop a framework with the guidance of the existing eLearning frameworks and framework development theories?

Sub-Research Question 4 (SRQ4): How can federated SNSs be validated and improved to gain an improved version that can be used as an eLearning tool in universities?

1.6 Central Theoretical Statements

Given the forgoing problem statement, research objectives and research questions of this study, we articulate the following theoretical statements on the development of an SNSs federated framework to be used as an eLearning tool by universities.

i) University students are the most active group using social networking sites. They are usually referred to as *digital natives* (Ementa and Ile, 2015) in the sense that, given an opportunity, they are willing to embrace and adopt more such sites, even if their primary purpose for this is not necessarily academic. In the Zimbabwean context, where internet availability remains low, most students gain access to the internet at their institutions. Although the use of smartphones can be of assistance, such an alternative is unfortunately hampered by network availability (Dlamini, Ncube and Muchemwa, 2015). This has a bigger impact on the number and types of SNSs used by each student.

ii) Existing eLearning management tools have been proven useful to students but lack socialising and instant feedback features. This is where SNSs apply because they are adept at facilitating group tasks like critical discussions and analyses and can 'learn' from the experiences of other students willing to share their experiences up to the point of achieving their goals (Pilli, 2014). The use of the federated SNSs as an eLearning tool is expected to become beneficial since students would spend less time on mere social sites but rather academic, embedded networks where academic activities are discussed.

iii) Many studies have already proven the benefits of using social networking sites as eLearning tools; consequently, the federation of SNSs is proposed to achieve even more benefits (Mehmood, 2013; Helou, 2014; Dlamini, Ncube and Muchemwa, 2015). Administrators, lecturers and students need SNSs within the education system for streamlining education activities. Other eLearning tools like LMSs must be explored to identify the deficiency the FSNS4eL would address. Such a customised platform could enable students to create presentations and content and share them through blogs and tagging (Nkatha, Kimwele & Okeyo, 2015).

iv) The similarities and differences between the types of SNSs mostly used as eLearning tools must be ascertained for the framework to be a success. This is useful when the proposed framework is designed, taking into consideration the most often available features present in most SNSs. Prior research finds that students use Facebook as their main eLearning tool, which might lead to the framework predominantly containing Facebook features for the tool to be user-friendly (Al-Mukhaini et al., 2014; Dlamini et al., 2015; Nkatha et al., 2015; Turan, Tinmaz & Goktas, 2013; Zanamwe, Rupere, Kufandirimbwa et al., 2013).

v) There exists a need for guidance when developing a framework; hence, framework development theories and methodology for the development processes would help in achieving an almost complete eLearning framework. Some elements of the framework (theory) development process were employed in the federated eLearning development; these

are the units of the theory, laws of interactions, boundaries and system states. The DSM principles guiding the development are *build* and *evaluate*, where the framework is first built and, thereafter, evaluated to improve the designed framework (Brady, Tzortzopoulos & Rooke, 2018; Ebneyamini, 2022; Lincoln & Lynham, 2011; Lynham, 2002).

1.7 Research Methodology

Rajasekar, Philominathan and Chinnathambi (2013) in(Fallah, 2018) define research methodology as "a systematic" technique of solving problems… "a science" of finding ways of doing research, … "the procedures" that should be adhered to so that a clear, step-by-step procedure of research is followed conscientiously. Data collection utilised both qualitative and quantitative (mixed) methods to gather comprehensive data. Quantitative data provided a wide scope to the study, whereas qualitative data add gravity (Dawadi, Shrestha & Giri, 2021, p. 27). Quantitative data were used to gather the data used to develop the framework; qualitative data were used to validate the framework. The mixed methods approach supported the study in building and testing theories and frameworks because they are not only compatible but also complementary where, in this case, quantitative research was complemented by a small but informative sample of experts who provided qualitative data (Molina-Azorin, 2016; Schoonenboom and Johnson, 2017; Dawadi, Shrestha and Giri, 2021).

1.7.1 Research Strategy

Research strategy is a method of inquiry that provides a stepwise link between philosophical assumptions, research design and data collection. It provides an overall direction in which the research should take place and the process involved in conducting research (Andersen, 2018; Marshall & Rossman, 1999; Wedawatta, Ingirige & Amaratunga, 2011). This study employed a case study (exploratory) to produce a federated social networking site (FSNS) framework as an eLearning tool in universities. We selected the Midlands State University (MSU) in Zimbabwe as the case study for the research to fulfil SRO1: *To investigate SNSs and provide their comprehensive characteristics*, and SRO4: *To evaluate and validate the proposed conceptual FSNS4eL and then deliver an improved version for further adoption*.

1.7.2 Research Philosophy

In this study, we adopted pragmatism as a research philosophy, which aims to reconcile subjectivism, objectivism, and fundamental and rigorous understanding and a variety of experiences. This is achieved by the evaluation of ideas, opinions and hypotheses. Thus, it takes a pluralist approach in combining both positivist and interpretivist philosophies since it interprets reality through subjective (socially created) and objective views, which permit us to capture phenomena through multiple methods, although the methodology should always be guided by the research problem. The paradigm values

objective and subjective knowledge that meets research objectives; it refuses to oppose quantitative and qualitative techniques by suggesting that the most important aspect is for the research to meet the study's objectives regardless of the method employed (Dawadi, Shrestha and Giri, 2021).

1.7.3 Research Approach

This study is inspired by design science research (DSR) in information systems (IS) theories as its theoretical foundation; it supports pragmatic philosophy, which aims to provide an understanding of dynamic environments as well as seen as a quest for improving computer user environments. Design science in information systems research primarily focuses on the development/design of artefacts, functional systems, architectures or frameworks intended to solve identified organisational problems and serve human purposes (Hevner et al., 2004b; March & Smith, 1995). It is an outcome-based IS research methodology with an interest in providing frameworks and guidelines for evaluation in computer-based research projects, where real problems are conceptualised, and appropriate models for their solutions are constructed, implemented and validated/reviewed using appropriate principles. The design science methodology is a six-step process model which guides a study from the problem development stage to the communication of the framework, that is, the recommendation of the framework.

1.7.4 Research Design

Research design comprises the structure of the entire research; it is referred to as the 'glue' that joins the elements that constitute a research project according to a designed flow, i.e., it is a systematic plan for the research to be conducted (Akhtar, 2016, p. 68). The research design indicates the starting point of the research, the endpoint, the deliverables of each stage and what is needed for each stage to be successful. Figure 1.1 below illustrates the research design of this study.

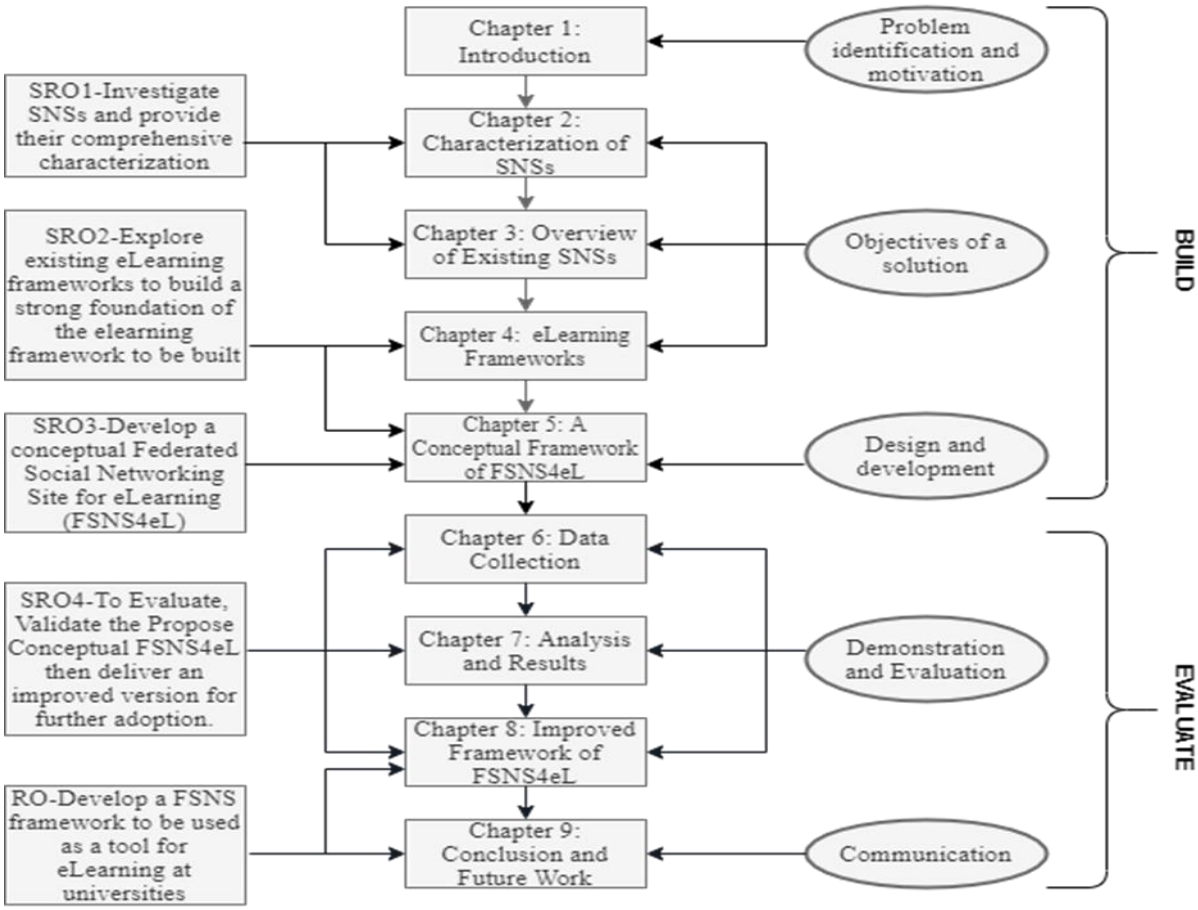


Figure 1.1: Research design

1.7.5 Literature Review

A literature review creates the foundation for the area under study, informed by extant research from different authors, i.e., SNSs, FSNSs, eLearning tools and eLearning frameworks. The literature review enabled us to answer two of the research questions of this study: *What are the existing SNSs, and what are their characteristics?* and *What are the eLearning frameworks and framework development theories in existence?* This enabled the study to determine the research deficit the current study addresses. Existent literature was reviewed where the characteristics and an overview of existing social networking sites, as well as the notion of existing eLearning frameworks, with the theories that guide building the framework were drawn from scholarly journals, conference proceedings, social media articles, news articles and even reports from the Zimbabwean government on this topic to provide a preliminary background of the study. The research proved to have enough literature to support the study since numerous scholarly articles on social networking sites, eLearning tools and frameworks exist. Hence, **SRO1**: *To investigate SNSs and provide their comprehensive characteristics,* and **SRO2**: *To explore existing eLearning frameworks to build a strong foundation for the prospective eLearning framework* would be answered to provide a concrete foundation for the proposed FSNS4eL.

1.7.6 Empirical Investigation

Collecting data from the key informants in the context of this research was useful, backed by a literature review to support the analysis and discussion of the collected data. This is expected to be very beneficial to developing the framework for the federated SNSs as eLearning tools in universities. The collected data were used to improve the developed framework. The DSM's *evaluate* aspect was fulfilled by the experts by providing qualitative data; the quantitative evaluated and improved or validated the data of the study. The empirical investigation answered **SRQ4**: *How can federated SNSs be validated and improved to gain an improved version that can be used as an eLearning tool in universities?*

1.7.7 Instrumentation and Data Collection Techniques

This research applied triangulation, whereby we considered both qualitative and quantitative data collection methods. We selected *explanatory sequential* mixed methods, whereby quantitative research is first conducted, and after analysing the results, explains the quantitative results in more detail with qualitative research (Creswell, 2014). The current research employed an online survey via questionnaires (closed-ended questions for framework development and open-ended questions for framework validation) for data selection using *Google Forms* because surveys provide a broader picture of the research questions (Nooshinfard *et al.*, 2012).

1.7.7.1 Surveys

The purpose of a survey is to analyse a condition or situation and probe participants to collect data on some aspect(s) of the population under study (Mathiyazhagan, 2010). Survey research employs quantitative research strategies such as questionnaires, on large population-based data collection to obtain opinions and study characteristics, explore human behaviour and even consumer feedback (Ponto, 2015). The study chose surveys, specifically questionnaires, since they facilitate a large sample size to allow generalisation of the research findings from the selected section of the population under study, although the information was not collected from the whole population (Mathiyazhagan, 2010). A survey (a questionnaire, in this study) is the best methodology for dealing with a large volume of data. The study dealt with unobservable data, such as why SNSs were accessed by students/lecturers/administrators and how many SNSs each student, lecturer or administrator had subscribed to (Ponto, 2015).

1.7.7.2 Reliability and Validity

The selected data-gathering methodologies tend to compromise the quality of collected data; hence there is a need to assess their validity and reliability. The reliability of the questionnaires and the validity of the developed framework must be considered. Reliability describes the consistency of the measuring tool; it is reliable if it can produce the same results if the same study is repeated, eliciting consistent responses. Validity maintains that the study measured what it intended to measure (Mathiyazhagan, 2010).

Validity is intrinsically more difficult to establish in a single statistical measure. A perfectly valid questionnaire, must measure in such a way that inferences drawn from the questionnaire are entirely accurate (Saunders, Lewis and Thornhill, 2012). The study applied Cronbach's alpha as part of its reliability testing and validation of the content, that is, as a pre-test.

1.7.7.3 Sampling

The population for the quantitative, empirical part of this study was divided into three groups, namely university students, university lecturers and university administration staff; expert reviews were added for the qualitative part of the study. A purposive technique was used to select the expert reviewers, with cluster sampling combined with random sampling for students and lecturers and cluster sampling for administrators. The sample size for the quantitative part of the study was determined by John Curry's rule of thumb and saturation was employed for the expert reviewers (the qualitative method).

1.7.7.4 Data Analysis

The study employed a mixed method by utilising two ways of analysing the data. Quantitative data are presented through charts, tables, frequency tables and inferential statistics, where necessary, using *SPSS* to analyse data. Qualitative data were synthesised, and the meanings extracted were interpreted.

1.8 Justification of the Study

This study is expected to be very useful in a learning environment, including for students, lecturers and supporting staff. When the model is integrated as a learning tool, most of the disadvantages of students using social networks would be reduced because of the control measures in place. Students would find their research simplified since it would be mostly embedded in the social networking sites where their precious time is mostly spent.

Communication between lecturers and students would be far easier since it would be taken as a formal means of communication. A message sent via social media is a much faster way of spreading news than any other formal means.

The administration of colleges and universities, in general, would be improved since most communication channels would be through this eLearning tool, which would be very effective since students are actively involved in SNSs. The use of such a tool could also be a cost-cutting measure, where the money for advertising or posting notices would be reduced, and there would be no need for printing learning material.

1.9 Delimitations of the Study

It was very difficult to build trust with the key informants because some of them would only meet us regarding the research. Most SNS users do not feel free to provide facts considering that some are

students and others (lecturers and administrators) are workers at the university, especially on the negativity of social networking, because they fear losing contact with their preferred means of social interaction. Nevertheless, convincing the respondents to fully participate in the study without any anxiety assured them that their participation was entirely for scholarly research and, if considered for implementation, would be to their benefit as well.

The institution intended to be consulted is only one university in Zimbabwe, this may not represent the whole population to the fullest but the use of statistical inferential would be advantageous to helping with population representation.

1.10 Ethical Considerations

We obtained approval from the Midlands State University Registrar, which was then used to apply for research clearance from the University of South Africa (UNISA) Ethics Review Committee (ERC). A cover letter with detailed information was provided to every potential participant, including but not limited to confidentiality, privacy and anonymity, whether they would be paid to participate or withdraw if need be. How they could access the analysed data and the study contacts were also provided.

1.11 Chapter Layout of the Thesis

This section presents the thesis layout with an explanation of the contents per chapter; thereafter, a graphical representation (figure 1.2) provides a summary.

Chapter 1 presents the introduction to the entire study; this includes the motivation for the study, the background to the study, the problem statement, the aims and objectives of the study and the research questions. In addition, the chapter presents some theoretical statements underpinning the study, the proposed contributions of the study, the ethical consideration and the diagrammatical structure of the thesis.

Chapter 2 characterises SNSs, defines social networks, explains their characteristics and discusses the functions of SNSs in eLearning-related or academic activities. The chapter also explores the positive characteristics of SNSs in education and their limitations and security issues. Thereafter, an introduction to the typology of social networking sites is given and an indication of the groups of SNSs, i.e., business-oriented, nonbusiness-oriented and academically oriented SNSs. This chapter introduces SNSs as an eLearning tool, reviews FSNSs and discusses the general architecture of SNSs to induct the proposed users on how they operate.

Chapter 3 provides an overview of existing SNSs by discussing four SNSs (Facebook, LinkedIn, YouTube and Twitter) regarded as the main SNSs by this study in detail, that is, their background and history, features and architecture. The chapter concludes with a discussion of the three principles

guiding the development of the framework for the federation of SNSs as an eLearning tool, namely *linked data, service decoupling* and *protocol,* and *architectural minimalism*.

Chapter 4 presents a background of eLearning frameworks by defining basic concepts associated with eLearning. This includes eLearning tools, types of eLearning and the benefits of the eLearning models, which leads to a review of different types of eLearning frameworks.

Chapter 5 discusses the formulation of the framework, guided by the DSM process and Dubin's theory-building's first phase processes. In addition, the development of the final framework is assisted by the architecture of the conceptual framework, which aids the study in identifying the units of the framework, the use cases aiding in establishing the laws of interaction that govern the theory, the flow chart determining the boundaries of the theory and the system states of the theory. The chapter discusses the peer-to-peer framework, the client-to-server framework and the hybrid framework—which is proposed as the framework of this study. Lastly, the criteria for framework validation and definitions of every element are provided to guide the reviewers in universally understanding the framework validation elements.

Chapter 6 explicates seven components, presented with the aid of the research onion, i.e., research philosophy, research approach, research methodology, research strategy, sampling techniques, data collection techniques and data analysis. The study discusses the design science process model used as a guideline for this thesis. The chapter discusses the John Curry rule of thumb guiding the sample determination process and highlights the ethical considerations underpinning the research process.

Chapter 7 presents data from three groups (students, lecturers and administrators) and demographic data, the response rates of each group, and the reliability test conducted together with statistical tests such as the Kolmogorov–Smirnov and Shapiro–Wilk tests, the Kaiser–Meyer–Olkin (KMO) test and Barlett's test of sphericity, Cronbach's alpha reliability test, factor analysis (on selected groups) and the hypothesis testing. This chapter determines the elements required for the redesign of the framework.

Chapter 8 discusses the feedback from the expert reviewers according to the validation elements declared, namely rigour and exactness, parsimony, completeness and logical flow/consistency. These contributions are aligned with the necessary literature before they are fused into the framework for the federation of SNSs as an eLearning tool. In addition, the chapter discusses the results presented in Chapter 7 and the feedback from experts presented in Chapter 8, validating the framework against extant literature. Lastly, Chapter 9 represents the conclusion of the study, in which a summary of all the chapters is presented, and discusses the research contribution, conclusion, limitations, recommendations and future studies.

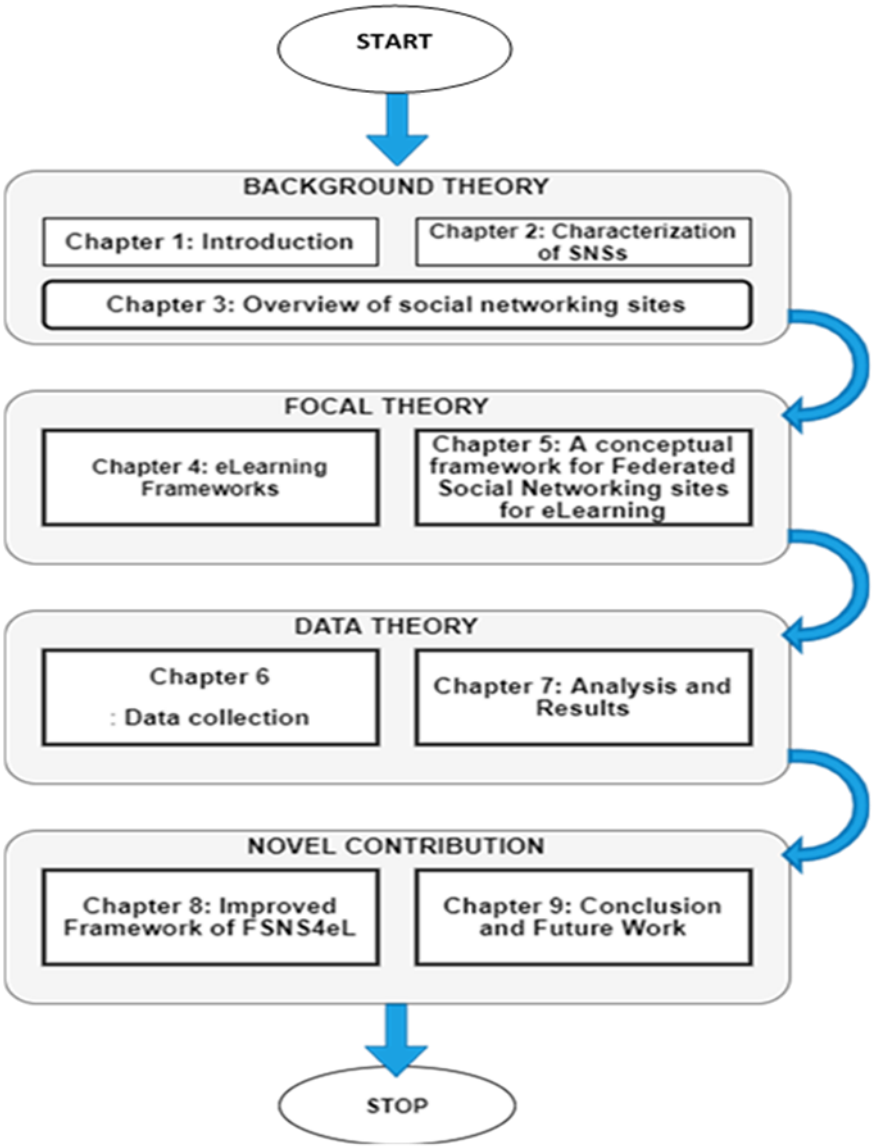


Figure 1.2: Structure of the Thesis

1.12 Summary

The main purpose of this chapter was to provide an orientation of the study, present the research objectives underpinning this research and the questions to aid in fulfilling the objectives. This study was guided by the research methodology, which includes the mixed method discussed in the chapter. The chapter stated the central theoretical statements underpinning this research, followed by a research design that ultimately led to an overall outline of the thesis in terms of an outlay of its chapters.

The next chapter discusses the characteristics of SNSs and the definition, types, characteristics and advantages and disadvantages of using them. This foundation assists in gaining an understanding of the area under study.

Chapter 2 : Characterisation of Social Networking Sites

2.1 Introduction

The previous chapter delved into the background aspects of the study. Thus, having stated the research questions in tandem with the research objectives in Chapter 1, the preliminary stage of the study articulates how this research was conducted. Moreso, to set up the steps the study pursued to produce the proposed federated social networking sites as an eLearning tool in most contemporary educational environments. Consequently, this stage contributes to the imperativeness of this study by providing a supportive literature review.

A thorough study of different contributory literature in Chapter 2 aids the research in having a structural direction within which to be guided by the views from the existing body of knowledge. SNSs are the focal point of the study since students are living an SNSs life; it follows that learning through SNS-aided education needs to be guided by an SNS tool that adds value to their educational life. In this Chapter, we answer the sub-research question: *What are the SNSs in existence and what are their characteristics?* thereby addressing the sub-research objective: *To investigate SNSs and provide comprehensive characteristics.*

This chapter defines social networks and explains their characteristics, attempting to provide an appreciation of the main terms used throughout this thesis. In addition, the chapter discusses the functions of these networking sites, specifically including the sites that benefit students in eLearning-related or academic activities.

The remaining part of this chapter is structured as follows: Section 2.2 discusses the overview of the intranet; Section 2.3 conducts an overview of eLearning; Section 2.4 introduces the social networks (SNs) and social networking sites (SNSs); Section 2.5 presents the functionalities of the social networking sites; Section 2.6 explains the advantages of social networking in education; Section 2.7 presents the limitations of social networking sites; Section 2.8 describes SNSs in general; Section 2.9 classifies social networking sites into three distinct groups; Section 2.10 discusses social networks as an eLearning tool; Section 2.11 presents the architecture of social networking sites; Section 2.12 investigates existing federated social networking sites (FSNS); Section 2.13 explores the characteristics of social networking sites (SNSs); Section 2.14 discusses the types of SNSs, and Section 2.15 concludes the chapter.

2.2 An Overview of the Intranet

An intranet is a privately owned or internal network created and used by organisations and educational institutions for its users to access network resources and other services essential to running day-to-day operations efficiently. The intranet also provides faster communication and safer collaboration among individuals in organisations. An organisation needs a private network through which staff can send and receive sensitive information with the minimum threat from hackers. Privately owned networks are usually associated with faster data transmission and more bandwidth, meaning they can run their day-to-day operations easily and conveniently (Miloslavskaya *et al.*, 2022). Large organisations are more prone to data security challenges than smaller ones; hence, they must own their intranet for relaying information across geographically situated departments. Every organisation has some services, content or information they might need to share privately and confidentially with their staff; thus, the intranet is the appropriate platform to accommodate such communication. An intranet can also be regarded as a knowledge management (KM) tool an organisation can use and make accessible only to authorised individuals for internal activities. Some of the benefits associated with the use of an intranet are that an organisation can mentor its workers towards making good decisions as well as retain its workers, thereby increasing productivity. Further, an intranet has benefits associated with educational institutions, whereby the costs of communicating, collaborating, discussions, information and content sharing might be reduced. The motivation for a sense of belonging to a community and socialisation in an enclosed and single context with other participants encourages individuals to work as a team (Urazbaev and Kholmatov, 2019; Tona and Sharma, 2020). There are three basic characteristics of an intranet:

- It utilises TCP/IP, HTTP and other existing internet protocols.
- The access to an intranet is restricted to one organisation, i.e., it is private.
- Like most internet facilities, it offers multiple operations, unlike tools like learning management systems that are utilised solely for educational purposes.

The features of an intranet make it ideal as an eLearning facility since it is cost-effective both in terms of money and time and offers a more secure environment for circulating information within an organisation (Moussa, 2016; Pentikäinen, 2021).

2.3 An Overview of eLearning

eLearning is an educational method that is offered online, facilitating interaction between school authorities and students. Lecture activities and other supporting learning materials to and from students are exchanged online. The benefits of eLearning in educational institutions include facilitating a high student-to-lecturer ratio, and eLearning, like broadcasting, can encompass the whole the whole student

cohort for a specific course being taught by one lecturer. The use of video illustrations compensates for those who work slowly or have difficulty listening. Students can play a video over and over until they understand its contents. eLearning is cost-effective in terms of the content being presented; the institution can produce soft copies and send them to a multitude of students, unlike hard copies, which are expensive to produce and difficult to manage. eLearning offers improved informational content sharing through platforms like YouTube, CDs, various learning management systems, discussion forums and even messages. Access to various learning materials promotes critical thinking and creativity through interactive communication and collaboration (Alsayed & Althaqafi, 2022; Pilli, 2014; Rawashdeh et al., 2021; Stecuła & Wolniak, 2022; Xhaferi & Xhaferi, 2020).

eLearning is an umbrella term that comprises learning tools like video conferencing, delivering and attending lectures via *Google Meet* and submitting and downloading notes on LMSs. Moreover, eLearning uses some internet protocols to transmit data, thereby enabling data security, both incoming and outgoing. Intranet facilities make eLearning activities more convenient and easier in terms of accessibility and content/information/data sharing, whereby searches or queries do not take long since content/information/data would be specifically for that institution. For eLearning to be effective, students need computers or other internet-enabled devices and internet connectivity, which can be achieved through mobile service providers who also provide internet services or through internet service providers to enable their effective participation in eLearning activities. SNSs such as Facebook, YouTube, X to mention but a few play a crucial role in eLearning as they have unlimited time for collaborations and discussions, they also facilitate informal learning through the use of blogs, TikTok videos not to mention the ubiquity characteristic of SNSs as compared to physical classrooms. Another factor to consider is the appropriateness of the eLearning tool, given the types of students being taught. For example, some students solely engage in distance learning, some require blended learning, and others might only need mobile learning, depending on the environment they find themselves in. Accreditation and affordability are other factors whereby institutions are roleplayers in making eLearning systems as affordable as possible for all students. This aspect would involve policymakers and other stakeholders since the issue of eLearning encompasses a need to increase the power of technologies, the availability of devices and internet access, and an environment conducive to teaching and learning (Dafoulas and Shokri, 2014; Ansari and Khan, 2020; Ismael, 2021; Kumar and Nanda, 2024).

eLearning is discussed in detail in Chapter 4, where the thesis presents the different types of eLearning systems, eLearning tools and eLearning frameworks.

2.4 Social Networks (SNs) and Social Networking Sites (SNSs)

A social network (SN) is a relationship shared among lecturers, students, administrators, parents and other university stakeholders that enables easier, faster and cheaper ways of communicating, news updates and information sharing enabled by web applications. SNs are enablers of easy communication, thereby enhancing social interaction and the exchange of learning materials and experience. They also motivate creativity and problem-solving capabilities that result in the improvement of students' academic achievements. SNs are a flexible way of knowledge exchange, access to news and event updates, a conducive platform for discussions, debates and collaborations, and excellent and conducive learning spaces, regardless of time and venue (Bateman, 2021; Froment, García González & Bohórquez, 2002; Gharrah & Aljaafreh, 2021; Mukhametgaliyeva et al., 2022; Pisar & Tomaskova, 2020).

Social networking is users connecting and establishing relationships with friends and family and socialising via SNSs. During social networking, users have virtual access to real-time news, online discussions and chatting with loved ones (Willems and Bateman, 2011). Social networking allows communities and users to cultivate friendships whenever they share similar interests. It is a critical medium to befriend others by identifying similar interests and can also be a contributory factor to successful business ventures and entrepreneurial skills development. Social networking can happen through group communication, communities with common interests, chat forums, collaborations, or one-on-one and, further, can occur online or offline, with online networking aided by the facility of SNSs and offline networking facilitated by gatherings such as camp meetings, conferences and other events. Social networking can be divided into socialising and networking: Socialising is participating in or belonging to a community while adhering to the norms and culture and learning from them. Networking is linking and creating connections with related or unrelated people in a community for socialisation, learning new and sharing ideas, and enjoying other benefits exclusively available to networked people (Alassiri, Muda & Ghazali, 2014; Algomaizy, 2020; Bucher, 2015; Marin, 2021).

SNSs are web-based platforms to which users subscribe to enjoy facilities like creating profiles, uploading and downloading content, sharing content, collaborating, debating, communicating (via instant messaging, video calls, etc.), and analysing and commenting on data for educational consumption. Furthermore, social networking sites enable the intelligent profiling of users, highlighting connections between participants and sharing and broadcasting content contingent on context. They also allow users to visualise, interact and activate existing personal and professional networks, as well as create connections with new networks, unbound by geographic distance (Madakam and Tripathi, 2021; Barrot and Acomular, 2022; Mutambik *et al.*, 2022; Tafesse, 2022).

Over the past years, social networking sites (SNSs) have increasingly become crucial global communication media. Major SNSs such as Facebook, Twitter, MySpace and LinkedIn have become familiar to millions of users and are still growing and attracting thousands of new users daily and,

therefore, becoming part of the daily lives of most internet users (Koç and Akbıyık, 2019; Saini *et al.*, 2020; Verduyn *et al.*, 2020; Mugoniwa and Ngassam, 2021).

2.4.1: Social Networking and Education

While most researchers frequently want to know why people are still interested in using SNSs, Ellison and Boyd (2013) improved their definition so that it may be more appropriate to the present day. Ellison and Boyd (2013) defined an SNS as a networked communication platform in which participants:

- have uniquely identifiable profiles that consist of content provided by other either or both users and system-provided data;
- publicly articulate connections that can be viewed and traversed by others and;
- consume and either or both produce and interact with streams of user-generated content provided by their connections on the site.

Regarding educational environments, most students use the internet almost daily, with many hours dedicated to SNSs. Thus it is important to identify the time and geographic limits to SNS usage rather than ban students from using social networking sites in educational environments. Importantly, students should be taught how to balance their academic work with their social lives so they do not waste time on social media at the expense of their academic activities (Dlamini, Ncube & Muchemwa, 2015a; Koç & Akbıyık, 2019; Mugoniwa & Ngassam, 2021).

Authors such as Ajibade and Zaidi (2023), Bateman (2021) and Gharrah and Aljaafreh (2021) agree that the main motivation for using online SNSs in educational environments is to communicate and maintain relationships for collaboration, discussions on particular topics and concepts, and up-and downloading learning material. Other popular activities include updating personal information and whereabouts (status updates), sharing photos, archiving events, receiving updates on the status of friends and family, sending and receiving messages privately, sharing ideas, pictures and updates on events and sharing information and knowledge gained through life experiences.

SNSs provide users with the facilities to share information and files and maintain friendships, which grants privileges to access friends' resources and connection channels. As such, with the aid of features such as blogs, sending messages and comments, chat rooms, receiving updates on friends' activities, adding photos and sharing interests. SNSs are applications that enable users to connect by creating personal information profiles, inviting friends and colleagues to access their profiles, and sending e-mails and instant messages (Algomaizy, 2020; Gharrah and Aljaafreh, 2021; Ajibade and Zaidi, 2023).

2.4.2 Contextual Definition of a Social Networking Site

Considering all the definitions discussed in previous sections, this study proposes a more appropriate definition that is relied upon in the context of this thesis: *A social networking site is a digital*

communication and knowledge-sharing platform for social and educational endeavours. Activities undertaken on a social networking site include, but are not limited to, user profile creation, content upload and download, information, data, image and file sharing, chatting and debating, news releases, data analyses and the critical consumption of posts for educational purposes.

2.5 Functionalities of Social Networking Sites

SNSs' main functionalities or features include but are not limited to identity management, expert search, context awareness, contact management, network awareness and exchange. We discuss each of the forgoing in the following subsections.

2.5.1 Identity Management

Identity management is a mechanism for governing user access and authorisation in SNSs for maintaining the confidentiality, reliability, authenticity and privacy of the content provided and accessed by users of the sites. This would include the issue of creating passwords, defining privacy criteria for hiding some information and defining criteria or user groups that are allowed to view some information on the account holder. For example, photos posted can only be viewed by users granted that right.

In principle, account owners should be aware that information posted on SNSs, if not restricted, can be viewed by the broader community of users. As such, posts should be published with caution since most people are associated with what they say or do. Indeed, if the account holder is a company, most SNS users would associate with and rate the company from its posts or publications. In the same vein, individuals can be evaluated by companies based on their profiles and publication history on SNSs. In the context of our research study, this principle also applies to students who may be searching for study partners to establish a study group based on common interests as well as the study of past trends (McConnell et al., 2017).

2.5.2 Expert Search

Expert search is a way to find implicit knowledge. In this context, a person has to be computer literate for them to be able to use this facility effectively. Someone searching for a suitable study partner should first ascertain their field of study to filter the search exactly as required. The same analogy can be made regarding a company, e.g., when searching for the right candidate for a position, the organisation must first list all the requisite characteristics of the candidate for the search to be more specific and attain somewhat accurate results. Learning how your area of interest is ranked also helps in expert search. The more users like a particular speciality, the more popular and useful the area becomes. Sometimes recommendations would accompany your results when searching for information, for example, the

common phrase “people who searched for this article also researched for these ones”. Ultimately, the list of articles would be produced and subject to analysis

In our research context, expert search it is very important to define boundaries of the search for example knowing search strings, search filter, the inclusion and exclusion criteria of a search helps the search results to be more useful to the students. The context in which the results fall under is usually determined by the students’ ability to use the search tools appropriately, thus one student may not find the expected answers on a given research topic which can be found by the next student because they have used different search techniques (Ahn and Lee, 2015; Bartoloni and Ancillai, 2023).

2.5.3 Context Awareness

SNSs provide an environment or background where users of the sites can view to see or seek information about friends, a company, or the institution they want to engage with. Most of these websites would have background information. For example, the Facebook website contains information such as where a person acquired their education, birthdays, birthplaces, a list of friends and current location. An institution’s information, such as its customers, products offered, affiliations and stakeholders, naturally defines its interests and type of institution. In the SNSs environment, the term *context awareness* can be taken to imply the framework one should utilise when searching for an institution or friends; it presents the user with some limits to what to expect when dealing with said company or person. Context awareness creates a sense of trust among users, which encourages collaboration because all are engaged in what they know, i.e., any weaknesses would be known beforehand

Students should know the intensity of their connections with other students, these includes common interests, common experiences, the level of education. this helps when students build communities for collaborations in school projects, entertainment or sporting programmes. The e way students are connected to each other promotes sense of trust, and gives assurance in this world of cyberbullying and scams (Clark, Algoe & Green, 2018; Mutambik et al., 2022).

2.5.4 Contact Management

Contact management is the functionalities that aid a user in maintaining their personal digital network. Examples of functions enabling contact management in SNS include tagging people and giving access or restricting users to access profiles (Subramani, 2019). With regard to security, there is a need for all users’ contacts to be secured and known only to a selected number of users. Private information, including users' contacts, birthdays, current locations and personal addresses posted on the user profile in an SNS, is often violated. As such, there is a need for robust contact management to keep the profile safe yet interesting. Thus, contact management can also be used for updating contacts; for instance, someone losing their phone’s contact details can easily use the SNS platform to search for them.

Contact management gives the students power to build, control, maintain and leverage their professional and personal networks at the university. the way they connect to other students and the groups they may end up falling into are also influenced by contact management. even the vulnerable one can be from cyber abuse is influenced by the way the contact is managed (Subramani, 2019).

2.5.5 Network Awareness

Network awareness enables users to be aware of the connections surrounding them and how they are linked to them with the aid of the right computer processes and tools. Users should know the structure of the network in which they are involved such that functioning within those networks is not too difficult for them. SNSs enable users to be networked, for instance, by receiving updates on current news and upcoming events. Networked platforms facilitate indirect communication; for example, sharing weddings and birthday events on the Facebook platform, whereby every Facebook friend would know about their friend's pending event

In our study, network awareness is when students are aware of the knowledge capital their network contains, this helps them to actively use the right platform, computer processes and tools to enhance their studies. in addition, the issue of updates like newsfeeds encourages the students to participate knowing fully well what was done in his/her absence (Stefanone, Iacobucci and Svetieva, 2016; Boruzie *et al.*, 2022; Nijland *et al.*, 2023).

2.5.6 Exchange

The exchange feature provides the ability to transmit information directly through, e.g., messaging or indirectly, such as forwarding photos and messages via bulletin boards, discussions and socialisation. SNSs have many facilities for exchanging information like chatting, messaging, posting information on a wall, sending pictures, videos, and various kinds of information updates enabling such exchanges. In this research context, students share information and knowledge through collaborating, uploading research, commenting on posts and rating content and videos (Baruah, 2012; Kibet and Ward, 2018).

2.6 Advantages of Social Networking in Education

Social networking in education enables users to collaborate, communicate and share information, whereby students and educators can access information and resources. This has been streamlined by the tools that facilitate students to exceed academic requirements by learning both in or outside the lecture hall, enabling them to repeat lectures, using brain-teasing tools and participating in discussions or debates facilitated online. SNSs have moved from being a mere socialising tool to becoming an important educational tool that can be relied upon.

2.6.1 Fostering Communication and Collaboration

Communication is at the core of any educational environment. In effect, if information is not timeously and correctly conveyed to stakeholders in the education environment, the entire ecosystem could suffer severe consequences. Similarly, collaboration among stakeholders in an educational environment could instil a culture of socialisation and commonality. Feedback channels are required to maintain effective communication. Through blogs, students and lecturers are given ample opportunity to interact and participate in discussions. This enforces a culture of teamwork in the academic context, where everyone can participate by collaborating and having discussions. The advantage of collaboration is that problems are addressed collectively, and solutions are shared among peers (Gupta, 2014; Munene & Nyaribo, 2013a; Zhu, Cao & Liu, 2022).

2.6.2 Supporting Research and Development

SNSs are regarded as important tools for sharing and obtaining new information. Research endeavours to gain knowledge and then use that knowledge to create new knowledge to be used by others in future, i.e., researchers create new knowledge using existing knowledge. Accordingly, SNSs maintain a pool of knowledge which is beneficial if used wisely. In most cases, SNS users share either or both successful experiments and discoveries on their profiles, whether individuals or businesses. There also exist other sites devoted to educational research; they provide researchers' track records and provide motivation by, for instance, displaying how many uploads, readings and citations occur per researcher. Consequently, researchers are encouraged to work hard for their research to be regarded as exceptional (Schlenkrich and Sewry, 2012; Ementa and Ile, 2015).

2.6.3 Motivation and Learning Opportunities

SNSs are platforms that can be used by students to showcase. Students can upload information or even research output, which helps them improve their content. Sites like *ResearchGate* upload the research output of upcoming researchers, facilitate research discussions and even allow topical discussions. SNSs enable such sites to post information without hesitation; they would receive feedback through comments, likes and ratings, which helps them improve or maintain the site. Learning is no longer limited by time and venue; students can undertake specific tasks in the comfort of their homes or elsewhere. Some tasks, like debates, are time-consuming and thus difficult to conclude and can be facilitated on SNS platforms where interaction can continue for days. A conclusion could be reached after realising that students are no longer contributing to the topic. Features such as groups in SNSs could be used to develop team spirit and oneness during discussions and collaborations. Students use these platforms to discuss their group projects, where everyone in the group can be seen participating (Zanamwe, Rupere and Kufandirimbwa, 2013; Bernard and Dzandza, 2018; Tsutsui and Takada, 2018)

2.6.4 Improving Educators' Capabilities

Students are free to contribute to SNSs; educators can take advantage of those platforms to become acquainted with the students they are working with. Those who need special attention can be identified

by the way they participate; in addition, status updates could assist educators in identifying students undergoing difficulties who might need counselling or other kinds of emotional guidance. The platforms are designed in such a way that every post can be reviewed and for feedback to be given on the same platform. Comments under tutorials help educators determine whether their approach is helping or confusing students, which means they could change their approach to teaching.

SNSs have many ways of enabling the capabilities of most educators; some sites enable educators to form groups where they can share teaching material, schemes of work and ideas on how to conduct particular lectures. Platforms like Telegram and WhatsApp are the most often used platforms, with WhatsApp being the most often used platform because it is easier to use than Telegram because WhatsApp facilitates the same platform used for conversations/chats being the same platform where documents are up- and downloaded. Moreover, Telegram is difficult to navigate; for example, searching for a chat or files for downloading purposes and logging out of the application (Bogos, Mocanu & Simion, 2023; Kim, Pak & Cho, 2022; Lirola, 2022; Seelam, 2022; Sleeman, Lang & Dakich, 2020).

2.7 Limitations of Social Networking Sites

Although SNSs have made a significant impact on modern society, and students connect, learn and interact with others online without limitations in terms of costs, distance and time, SNSs are not without flaws. The limitations and drawbacks of SNSs can range from minor to major, and the significance of damage they cause also varies. The next sections discuss some SNSS limitations and drawbacks to establish ways of minimising the impact of or completely solving their problems.

2.7.1 Security in Social Networking sites

SNSs are characterised by user-friendly features such that even a user with a low level of literacy can use the platforms. However, some may lack basic security measures, making them prone to cybersecurity attacks such as phishing[2] and pharming[3]. Today, hackers are attacking SNSs without much difficulty; this has led to an increase in spam messages with fake advertising material in users' accounts. This has become a cause for concern to the users of such platforms, especially those with entry-level privileges to the platforms.

When using SNSs, users regularly face two types of security threats. The first relates to unsecured communication channels among interacting participants because their conversation or information

[2] The unscrupulous practice of sending enticing emails or SMSs, text messages purporting to be from genuine sources to steal personal information, such as personal credentials, banking details, card numbers, etc. (Abroshan et al., 2018; Bhavsar, Kadlak & Sharma, 2018)

[3] The malicious and deceitful practice of obtaining personal information from internet users, such as passwords, account numbers and so forth, by directing them to fake websites that mimic the appearance of legitimate websites. This could be achieved by installing code that diverts legitimate links (Azeez, Oladele & Ologe, 2022; Chiappini & Schifano, 2020)

sharing is not encrypted. The second issue is information leakage through third-party applications, which could promote phishing, eavesdropping and hacking.

SNSs users often intentionally or unintentionally post sensitive data on those platforms, making them prone to a range of exploitations by attackers, such as blackmailing, identity theft or fraud. Therefore, users should be educated or at least made aware that the disclosure of their private information, such as date of birth, address and profile, exposes them to many security threats that might be exploited by cybercriminals. Sadly, investigations reveal that not only are end users of SNSs not aware of their levels of cyber-exposure, but many SNSs in the digital world also remain unsecured (Ali et al., 2018; Khatri & Paudel, 2021; Mutambik et al., 2022; Segado-Boj & Díaz-Campo, 2020; Zhu et al., 2022).

2.7.2 Legal and Regulatory Matters

Users subscribed to SNSs can use these platforms to indulge in various activities that may be illegal, for example, the theft of intellectual property, online bullying, privacy infringements and defamation of character. Students who use these SNSs have to consider another aspect, i.e., while communication is cheaper through SNSs and access to information easier, it is inarguable that students might be vulnerable to many online-related risks. As such, institutions are not spared since they could suffer the same fate. SNSs can be used to spread fake news that might even cause harm to people's lives; unfortunately, there are no sources or evidence this study came across that indicated the aftermath of sharing such news. The other problem that accompanies sharing fake news is that there is no way to authenticate such news before forwarding it. When uploading content, students might not understand the value of their work, which might, in turn, be taken possession of by SNSs owners for free to their benefit. Instead, if guided on how to protect their work, they could publish their copyrighted content and enjoy benefitting from their patents. Whether or not deliberately, the terminology used in the terms and conditions of SNSs and their extraordinary length causes most users to just accept them without truly understanding their contents (Barrett-Maitland & Lynch, 2016; Henderson et al., 2010; Talwar et al., 2020).

2.7.3 Suspect Information Quality

Some information posted on weblogs is not always reliable because most of these sites are open source, i.e., anybody is free to communicate their ideas and feelings. Most of these weblogs are created to garner views and ratings. This means anyone eager to attract many views would think of what people are more likely to respond to and post exactly to that notion. It is imperative to analyse information found on these sites because users might very well upload their views without undertaking proper research. Users should be mindful that SNSs are used by many different kinds of people from different parts of the world. Information might not necessarily be true, reliable or applicable, even if its quality seems good (Abbas, Hosnavi & Tabrizi, 2019; Zannettou et al., 2019).

2.7.4 Managing Personal and Professional Time

Because everyone who uses the internet is a member of at least one (often many) online social network, unsurprisingly, these social networks have impacted the way people live and socialise. In most developing countries like Zimbabwe, academics predominantly access the internet at educational institutions since they have no other source of internet from home due to high data costs, poor network coverage or a lack of devices. Hence, SNSs users must be disciplined during working and learning hours; they should be able to balance and manage their time to prevent them from neglecting their professional responsibilities. For students, a considerable disadvantage is choosing to access platforms even during lectures, which has significantly affected how they study. Since this is not appropriate academic conduct, facilitators are negatively affected when they realise that a student is accessing SNSs during their lectures. These students would display a conspicuous lack of concentration and interest in the lecture proceedings. Under such circumstances, a feedback review by students can be very confusing and meaningless since a lack of concentration might not be directly linked to how the lecture was delivered but instead to the student's behaviour during the lecture. Most students spend increasingly more time on SNSs, engaging in activities unrelated to their academic work because of the addictive nature of these social networking sites. It has become a widespread concern that students may fail to balance their studies and socialising because most of their time is spent on activities unrelated to their coursework (Abbas et al., 2019; Bernard, 2020; Masrom et al., 2021; Munene & Nyaribo, 2013b).

2.7.5 Lack of Professionalism

The use of social network sites like Facebook may reduce the way people used to respect or value each other because of limited physical connections. The use of shorthand writing is rampant in SNSs messaging, and if not managed, could affect whole conversations because it might be difficult to understand and could show disrespect to the user on the other end. Because a site was initially created for socialising with others, it might be difficult to take anything on the site seriously, which might cause important messages to go unread for long periods, thereby reducing the effectiveness of SNS communication (Rambe, 2011; Boothe-Perry, 2013; Chester *et al.*, 2013; Hook, 2016; Almutairi *et al.*, 2022; Gagrčin and Porten-Cheé, 2022; Love *et al.*, 2022).

2.8 General Description of SNSs

The emergence of SNSs is significant to the contemporary generation and has proven vibrant platforms for effective communication and the dissemination of information due to their low cost and speed of communication. In addition, SNSs facilitate creating and sharing information, as well as maintaining connections, interactions, collaborations and chats. SNSs are not limited by cultural and geographical barriers: Anyone anywhere can subscribe and enjoy their benefits.

This section of the thesis discusses the basic concepts used in social computing. These concepts shape the way the users communicate by proving the means of organising data, how users must interact, the

content and events found on SNS platforms and the concept of security and privacy (Sungkur and Rungen, 2014; Hussain, Loan and Kubravi, 2020; Saini *et al.*, 2020; González-Nuevo *et al.*, 2022).

2.8.1 User Profile

This is a personal page where information like age, gender, location and a profile picture of the subscriber is displayed, as well as information such as employment history, interests, education qualifications and relationship status. SNSs users can customise and manage their profiles to their preference, where customisation might include themes to personalise their pages. Users may use photos, videos and other multimedia content to showcase their interests and activities.

SNSs have the mandate to use the information provided to suggest groups, friends and pages that might be of interest to the user. In addition, the information provided may be used to select advertisements that suit users' preferences. The main purpose of profiles is to enable connections between users for relationships and group formations for online information exchange (Bateman, 2021; Burnell, George & Underwood, 2020; Qahri-Saremi & Turel, 2020; Sleeman et al., 2020).

2.8.2 User Connections

User connection refers to an online or virtual relationship between two users on SNSs. Connections are created based on an individual's interests, their usual types of searches, the communities and groups they had joined, occupations and many other factors. SNSs then use such information to suggest or create connections; these may be based on a person's previous job searches, content searches, or a recent friend request the person had accepted. Such connections can be in the form of friend suggestions, group suggestions or content updates on particular topics. Platforms use these connections to personalise content and recommendations for individual users based on their connections and interactions with others. When an individual views particular profiles on SNSs, a suggestion to connect you to the owner of the profile usually follows, and if there is a friendship acceptance, a connection is created. These connections are useful for news updates and joining useful groups; for example, a user interested in farming might receive many group suggestions and, when connected, could benefit from vast amounts of information on farming—either free of charge or at a cost.

Two types of connections on SNS platforms can be a reciprocal connection, which requires both parties to agree to the connection; the other is an asymmetrical connection, which requires just one user to initiate a connection. These connections give users access to a wider pool or variety of information, some of which are new opportunities for users to grow personally or even professionally; some are motivational speakers who dedicate their time and provide speeches to encourage others; health information is posted in different groups; and some might be inspired by role models they might have had the opportunity to connect with (Koç and Akbıyık, 2019; Burnell, George and Underwood, 2020; Pisar and Tomaskova, 2020; Bateman, 2021; Marin, 2021; Tafesse, 2022).

2.8.3 Content

SNSs are rich in different types of content, varying between posted messages, up- or downloaded video and audio, and any other information shared or consumed on the platform. Content on SNSs can take many different forms, ranging between images, texts, videos, audio and even live streams. Social, business and academic information is found on different types of SNSs and varies with the type of SNS. Different types of users contribute to content creation on SNS platforms in terms of gathering news as it occurs. Interestingly, some news stations are now even reporting and quoting that their information was found on Twitter; some users post their artwork or images taken on outings, while others research a topic and find interesting information they feel should be shared. All of these constitute content that could be useful to different SNSs users. SNSs platforms serve as hotspots of information and users are free to exchange information by up- or downloading, discussing, debating, etc. (Ali et al., 2018; Almutairi et al., 2022; Barrett-Maitland & Lynch, 2016; Gagrčin & Porten-Cheé, 2022; Marin, 2021).

2.8.4 Events

Events are any periodic activities or occasions that users find worthwhile to share with a group of people and can include birthday parties, concerts, political rallies or charity movements. SNSs enable users to share, manage and even create moments; these can be shared with friends, family and followers. Events on social networking sites (SNS) can be generated by users within their communities or captured from content updates by other users, including foreign users. SNSs provide options users use to create events; these selection options may consist of event type, location, date and time and description; users can invite people to attend an event by selecting particular friends or groups, or they can choose to make the event public with the aid of the facilities on SNSs. SNS platforms store most of the events in repositories to allow for easy distribution and to generate reminders of upcoming events, for example, birthdays (Sattikar and Kulkarni, 2011; Sungkur and Rungen, 2014; Pal *et al.*, 2017).

2.8.5 Security and Privacy

Security in information systems is the protection of data from unauthorised access, modification, disruption, destruction, use or even disclosure. Privacy is when an individual has the right to manage the use, disclosure, collection and dissemination of their private and or personal information. Private information must be properly managed to avoid difficulties like the violation of private data, thereby avoiding the dire consequences of such issues. Users subscribed to SNSs share their personal information freely; hence SNSs platforms must have strong privacy policies to protect their subscribers' personal information from unauthorised use, access or disclosure. The personal information users usually share includes their locations, photos, names and holiday outings; some users even go to the extent of showing off their expensive belongings. SNSs should accept the mandate of educating their users on the safe and responsible use of SNSs and online activities in general to reduce the risks associated with online data disclosure. The developers of these SNSs should prioritise security and privacy issues on their platforms to protect individuals' data, such as end-to-end encryption, enabling privacy settings and implementing authorisation and authentication systems to protect users from

unauthorised access and the disclosure of their data (Jain, Sahoo & Kaubiyal, 2021; Kayes & Iamnitchi, 2017; Nawalagatti et al., 2022; Park & Kim, 2020; Zlatolas et al., 2022)

2.9 Groups of Social Networking Sites

SNSs are classified into three categories, namely business-oriented, nonbusiness-oriented and education-oriented. However, almost all social networking platforms have the same basic features, such as profile management, up- and downloading, and messaging, among others. Businesses are mostly interested in client services as well as brand and product marketing on SNSs. Recreational and educational SNSs mostly focus on social chatting, academic content presentation and sharing. The subsections below discuss each group of SNSs.

2.9.1 Nonbusiness-Oriented SNSs (NBSNSs)

NBSNSs are online platforms that primarily focus on social interaction, connection and networking instead of business/educational purposes. These platforms are designed for social interaction, communication and connection with people who share some common interests, social backgrounds and hobbies.

NBSNSs are applications developed based on using personal information to promote social networking between people. Most of these sites are used by individuals to strengthen their social relationships; SNSs provide a facility to chat with relatives and friends anywhere or anytime quickly and cost-efficiently. These SNSs help in communicating important updates like birthday messages which are automatically generated by the sites based on the information the user supplied when creating an account. Users can use these platforms to invite their friends to functions and communicate either good or bad news. Some additional features on the platform include sharing ideas, pictures, posts, activities, events and interests among subscribers to the network. NBSNSs are also known as socially oriented networking sites. SNSs in this category are mostly meant to create entertaining environments to such an extent that if a person is bored, the first thing for them is to check for messages or news updates on their profile to alleviate the boredom.

There are usually no limitations to the usage (especially uploading and downloading) of information on these SNSs. The limit would only be on viewing some, not all, pictures and videos. Some examples of NBSNSs are Facebook, MySpace, Google+, Twitter, Flickr, YouTube, Flixster, Badoo, Ning, Instagram, Friendster and Tumblr, to mention but a few, although some of these are also used by business people (Alassiri, Muda and Ghazali, 2014; Jain, Sahoo and Kaubiyal, 2021).

2.9.2 Business-Oriented SNSs (BSNSs)

BSNSs are built for business activities such as selling, talent-seeking, jobs, goods and services advertising, job-seeking, professional networking, sharing business ideas and other business-related

information. These platforms enable and assist businesses to connect with other businesses, potential clients, potential suppliers and advisory professionals towards business expansion.

BSNSs allow applicants to interact through business-oriented information, endorsements, testimonials and reputation management. There are different types of BSNSs, such as some developed specifically for a company; some that can be used by a specific company as well as the outside world; and other that can be used by employees of different companies sharing information and experiences.

SNSs specifically customised for a company are mostly created by a delegated system developer from the company with the help of departmental specialists within that company. The departments would provide the developer with the information they want to appear on the site. Thus it becomes an in-house made application. Another option is for an organisation to take advantage of an already existing business SNS, which is a less costly option since there are no development and maintenance costs. Some SNSs are also used by employees for sharing ideas among different organisations within a similar industry. In addition, employees can use the platforms to advertise workshops, mostly without much direct involvement from the employer or company.

BSNSs are not very common since most of them are developed in-house and never used outside the company. This means that only employees and a few stakeholders with access credentials can be part of the network. Examples of BSNSs include Hi5, 12manage, LinkedIn and Yelp (Briliana, 2016; Chauhan, Lekh & Sanjay, 2021; Marolt, Zimmermann & Pucihar, 2022).

2.9.3 Academically Oriented SNSs (ASNSs)

ASNSs are specifically for academic connections to communicate, collaborate and share different types of content they have accessed, researched or created. ASNSs provide a platform for each member to create a profile which allows them to connect as scholars and share information on their publications and research areas. Researchers and their counterparts can also use the websites to schedule meetings, discussion forums or chat sessions to share information assigned among them to research. Such platforms provide significant benefits to users, such as collaborative writing, the discovery of new research and academic supervision. *Mendeley* is one such site that provides information on how to cite in academic writing and, indeed, maintains a database of academic articles for researchers. On these sites, academically related advertisements are found, for instance, scholarship opportunities. Generally, ASNSs exist to assist academics in the journey of their studies, to streamline the process by researching, sharing information and using facilities like keyword searches to find information.

Examples of popular ASNSs include *Academia*, *ResearchGate*, *CiteUlike*, *Bibsonomy* and *Zotero*. These platforms contain various tools to assist scholars and researchers with several effective and efficient ways of researching, academic writing, information sharing and collaborating (Bhardwaj, 2017; Jordan, 2019; Hailu and Wu, 2021; Mazurek *et al.*, 2022).

2.10 Social Networks as an eLearning Tool

Social networks have since become a part of contemporary life and are increasingly being integrated into eLearning platforms, making them valuable eLearning tools. Social networks such as Facebook, Twitter, Instagram and LinkedIn enhance the learning experience by providing a platform for content creation, interactive learning and collaboration. Social networking sites have the potential to influence students' performance in both their social skills and academic achievements. Students are currently using social networking sites for various purposes, including learning and socialising. It has become difficult to separate social networking and students' activities because their daily routine entails, among others, socialising with peers and interacting with them for academic reasons. (Khan & Tahir Bakhsh, 2015; Mukhametgaliyeva et al., 2022; Ostic et al., 2021).

SNSs such as Telegram and WhatsApp groups can be formed for eLearning purposes and can be used for topic and lecture discussions, collaborations on assigned projects, debates, sharing academic information, and even obtaining updates on classes. For instance, students normally form WhatsApp groups to share relevant scholarly articles, papers, journals and other coursework material. The WhatsApp platform has proven a relatively cheaper means of communication and mode of sharing information; its user-friendly interface has persuaded students and facilitators to choose it for most tasks (Alaslani and Alandejani, 2020; Barrot and Acomular, 2022; Bocar and Jocson, 2022).

Students typically use Zoom as a theory platform for video conferencing enabling virtual classes, webinars and online meetings. Zoom is an excellent platform for real-time communication with excellent video and voice output, provided users have a strong internet connection. Platforms like YouTube and Flickr can assist students with facilitating group discussions, where students can share videos and other learning material, with commenting also a powerful tool for shared content (Almutairi *et al.*, 2022; Stecuła and Wolniak, 2022).

Traditional learning platforms like learning management systems (LMSs), e.g., *Moodle,* are gradually being replaced by SNSs such as Facebook, Twitter, Telegram and WhatsApp because these SNSs offer more lively engagement and interactive features such as group discussion forums, live videos and virtual conferencing. Other features include sharing links to trending topics and real-time responses (Stone and Logan, 2018; Giannikas, 2019; Ghounane, 2020; Tran and Pham, 2023).

2.11 Architecture of Social Networking Sites

One cardinal goal of social networking sites is to provide users with real-time communication with other users at any time to fulfil their socialising goals. Therefore, the design of SNSs should be done in a way that enables them to fulfil such critical obligations. The main components of the SNSs are discussed below:

User Interface (UI): A connection or a link that enables users subscribed to SNSs to interact, of which the main features usually found are profile pages, messaging facilities, notifications, updates/newsfeeds and settings.

Database: User data is stored and managed in the database; examples of user data include posts, profile information, events, comments and user-generated content.

Application Server: Where user requests are processed, and security measures such as authentication and data validation are handled.

Application Programming Interface (API): A set of protocols provided by SNSs to allow third-party developers to develop applications that integrate with SNSs.

Content Delivery Network (CDN): Content is distributed to users by a network of servers, CDN, typically used by SNSs to reduce latency, speed up content delivery and improve overall SNS performance.

Security: SNSs protect user data from security threats like hacking, unauthorised access and data destruction with different security measures that vary between SNSs. This might include encryption, firewalls and other security protocols.

Figure 2.1 displays a prototype of a general architecture that represents huge networking sites like Facebook or YouTube. The components include load balancers, web servers, applications servers, memory caches, database servers and the databases in order.

SNSs web servers use protocols like firewalls and HTTP traffic manager to manage incoming requests by blocking or redirecting unwanted or ill-formed traffic using a traffic shape to smooth out peaks in requests.

Application servers oversee the availability of both the services and user access protocols. Their responsibility is to make data accessible to users, and only filter and transmit relevant data to prevent unnecessary data overload.

Memory caches are designed to meet performance and scalability challenges in SNSs. They are designed to monitor TCP sockets for inbound requests and employ hash tables to swiftly respond to metadata keyword searches since the MemCaches store the most frequently used contents, such as a user's member ID.

Each database server is paired with a backup server to address performance, scalability and availability challenges. In case of a server failure, the backup server would be responsible for processing the workload. Regular database backups are conducted daily, weekly, bi-weekly or monthly to ensure data integrity and facilitate recovery from server crashes or hard disk drive failures (Rohani and Hock, 2010, p. 48).

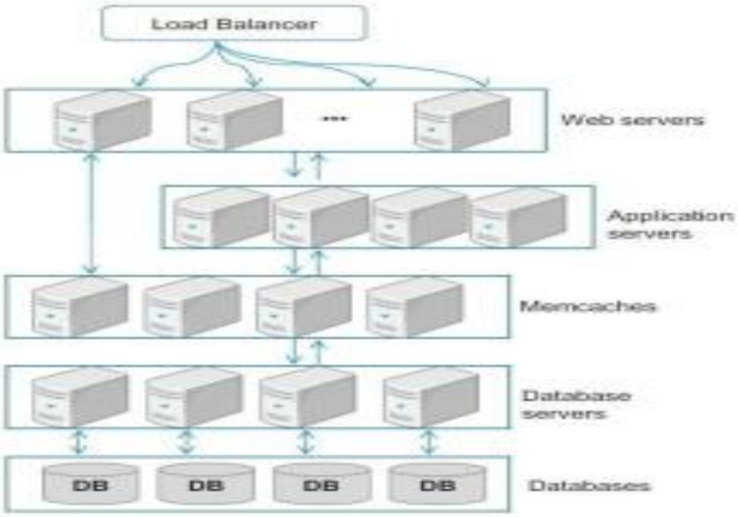


Figure 2.1: An architecture for huge social networks (Rohani & Hock, 2010)

2.12 Federated Social Networking Site (FSNS)

A federated social networking site is a social networking ecosystem with standard-based interoperable social networks enabling any SNS profile to interact with another SNS profile in the ecosystem interchangeably. In an FSNS, users can choose from an array of SNS profiles in the same way connections or contact are searched and enabled in a standalone SNS. The sections below discuss some existing FSNSs in the literature.

2.12.1 OStatus

OStatus is an FSNS that comprises several protocols, such as *ActivtyPub*, *Webfinger* and *Salmon*, working together to enable users to publish and access content on different social networks and web services without losing control and privacy over their data. Communication and social networking are decentralised without being tied to a single social network or platform across different platforms, with a set of open web standards that govern the interconnectivity and interaction of users in different SNSs (Maka, 2011; Narayanan *et al.*, 2012; Silva *et al.*, 2017).

OStatus enables real-time interaction between different social networks, with a combination of protocols such as *Atom*/*RSS* that enable syndicating content to and from SNSs as part of the interactions that make federation possible. The protocols included in OStatus are:

- *PubSubHubbub* is used for publishing and subscribing with the aid of central hubs to subscribe and publish new content and updates. This is an extension of the *Atom/RSS* protocol.
- *WebFinger* is used for determining information through standard identifiers that solve the problem of sharing identities between servers.
- *ActivityStreams* defines a format and standardises entity formats to objects from different servers.

- *Salmon* combines *Atom* and *PubSubHubbub* protocols that enable publishing and updating information across servers in real time.

2.12.2 Lorea

The League of Researchers on Advanced Education (LOREA) is a network of researchers, activists and educators based in Europe committed to exploring and promoting new models of social organisation and education based on principles of openness, cooperation and social justice. LOREA is a self-managed federation of networks that raised a collective of people (with knowledge of free software and 'technological activism') who needed solutions to the security and privacy of their social web. The network is committed to developing and using technologies that guarantee messages are circulating on its networks and can only be accessed by their intended target. LOREA uses GPG (*GNU Privacy Guard*) encryption on some of its messages and to ensure security such that its networks are not configured by default. LOREA stresses the development of groups that activate all resource needs rather than individual activities in their networks (Cabello, Franco & Alexandra, 2013). Lorea features include:

- Custom profile page and dashboard where users can choose different plugins and features to display.
- Multimedia galleries where wikis, pads, blogs, bookmarks and task manager are displayed.
- Status updates, updates all activities by users of the network.
- Events calendar where things to do are listed, reminders to attend chat rooms and discussions.
- Privacy awareness supports GPG encryption on messages and encourages peer-to-peer connection between users.

2.12.3 OneSocialWeb

OneSocialWeb (OSW) is an open-source scheme that creates a decentralised and standards-based SN platform built on existing *XMPP* (*Extensible Messaging and Presence Protocol*) technology enhancements and *Personal Eventing Protocol* (*PEP*) extension which specialises in *Publish–Subscribe* extensions that are away from hosting servers at random *XMPP* entities near server-provided services which are addressed by a user's *Jabber* id (*JID*). OSW was launched in 2008 and led by a group of researchers and developers from different universities, such as the University of Southampton, the University of Cambridge and the Open University, aiming to introduce user-centricity and awareness of user privacy associated with social networking activities. The purpose of OSW is to encourage individuals to have sufficient control over their data and interact interoperably with other users. The OSW was developed in such a way that it is sufficiently flexible and scalable to allow for encompassing both private and public social network services. Several components of OSW (web, server, mobile clients and libraries) are useful in building social networking applications (Maka, 2011).

2.12.4 Diaspora

Launched in 2010, Diaspora was built with the notion of user control and decentralisation as well as the principles of privacy and security, whereby users are encouraged to create and manage their own 'pods' connected to a large network of Diaspora with the facility of a protocol called *The Diaspora Protocol*. Diaspora was proposed to curb problems of privacy and freedom raised by users, who then obtained the mandate to maintain it after a crowdfunding campaign for its development. Diaspora's main aim is to avoid content centralisation, characterised by a shortage of central control over user data, by initiating a technology called pods, a network of personal servers. An individual pod stores user data, only allowing them to communicate with users on different servers (Narayanan *et al.*, 2012; Silva *et al.*, 2017). The protocol specifications of Diaspora are:

- Remote Users: The process of recognising remote users to enable them to interact with users from different networks.
- Message Exchange: Messages are exchanged via a subset of the *Salmon* protocol; the *Diaspora Protocol* facilitates message-building and encryption, then sends them to the *Salmon* destination pod.
- Protocol Flow: Diaspora uses *WebFinger* and *hCard* standards to determine identities and then fetches public profiles from foreign servers.
- *ActivityStreams* and *PubSubHubbub* can also be used by Diaspora to provide feeds meant for the public.

2.12.5 Other Federated SNSs

In addition to the above-mentioned FSNSs, several other federated social networking services (SNSs) are designed to offer users greater control over their data and privacy. They prioritise privacy and security, allowing users to have more control over who has access to their data (Paul, Famulari & Strufe, 2014). Some of these platforms are briefly explained below:

1. SoNet: Avoids the implications of P2P mechanisms by suggesting an XMPP-like architecture where every node is connected to one server to "obfuscate the social graph by introducing single direction pseudonyms" (Paul, Famulari and Strufe, 2014, p. 445).

2. Mantle: A DOSN approach with the idea of leveraging random storage to store user data.

3. PrPl (Private Public): Allows data to be stored in the users' comfort zone by selecting the storage resources they trust. The platform uses *SociaLite*, which enables developers to query data from *Butlers*.

4. Anderson: Aims to protect personal data from unauthorised access, hiding social graphs and assuring content integrity.

2.13 Characterisation of Social Networking Sites (SNSs)

Social networking sites are numerous and have varying characteristics; however, this study investigates characteristics common to all online SNSs. This section discusses the characteristics of SNSs in five subsections, namely Profiling in SNSs and Connections in SNSs.

2.13.1 Profiling

Users customise and manage their profiles by uploading content, uploading pictures, updating events and sharing moments. This enables other users to view and comment on such content, meaning they would respond either by comments or likes or any other response of their choice. Profile management includes uploading profile pictures, adding dates of birth, indicating location and providing educational background and work history, among others. Customisation usually entails a user changing the background of their profile or adding stickers and other transitions. Some friends of the individual could view and leave comments, while others might view and leave no comment; interestingly, even the owner of the profile can always view, update or delete some of the content on their profile. Content on profiles can serve as building a history, which users may reflect when a certain milestone has been reached. Friends may learn about the weaknesses, capabilities and even sorrows faced by the user whose profile they access, thereby learning the social standing of their counterparts. Users employ profile pages as a facility for disclosing their status, whether or not they are happy, which usually results in words of encouragement or comfort (Burnell, George and Underwood, 2020; Sharif *et al.*, 2021).

2.13.2 Interactivity

Interaction enables effective communication, which results in strong and long-lasting relationships. Tools for interaction consist of calls, video interactions, audio recordings and instant messaging. Through synchronous communication, students are encouraged to work in groups and collaborate on assigned tasks; they can discuss and ask questions on topics they have found challenging. Interacting via SNSs reduces stage fright, boosts confidence in students' knowledge and increases knowledge through activities like debates and discussions (Almahmoud, 2019; Cavus *et al.*, 2021; Gharrah and Aljaafreh, 2021).

2.13.3 Entertainment

Students always find interesting ways of doing their work to avoid boredom and fatigue. SNSs provide entertainment to students through different functions, including video uploading, audio listening, debating, status updates and even group chats. Entertainment creates a positive atmosphere around subjects, encourages users to participate in particular activities and increases a sense of belonging. When a user enjoys certain activities, it improves the probability of them repeating them, thereby increasing the likelihood of understanding the subject matter (Almahmoud, 2019; Koç and Akbıyık, 2019; Cavus *et al.*, 2021; Gharrah and Aljaafreh, 2021; Mukhametgaliyeva *et al.*, 2022; Tafesse, 2022).

2.13.4 Connections

Friends and family who are physically separated always have the ability to bridge the distance through online connections that do not have any geographical boundaries. The physical distance between relatives, friends and study partners is not realised when they are connected online. Online connections are much cheaper compared to traditional methods of connecting since communication and travel costs are complemented by online connections. Connections can happen as a result of a person's profile or the information and content displayed on profiles, which usually attract followers and friends since the interested party might have the same interests as those seen on the profile. New connections would need to request connection and permission, like on Facebook, while some allow users to link without permission, like in Flickr and Live Journal. The auto connection type is not preferred by many users for security reasons; knowing the users you are connected to reduces the chances of data security issues. However, most sites offer a platform for participants to find friends or contact fans using some criteria that would require the other party to confirm whether they know where the request is coming from and a few of them would just send the messages as they are to the required person (Koç and Akbıyık, 2019; Bateman, 2021; Madakam and Tripathi, 2021).

2.13.5 Communication

There are two forms of online communication: synchronous and asynchronous. Synchronous communication enables one to send messages that can be replied to at the same time in the form of chats, instant messages, video interactions or voice calls. SNSs enable synchronous communication through:

- Instant messaging: When users are chatting, their messages are sent in real time (with the right network connectivity) and the response rate is fast.
- Voice calls through SNSs depend on internet connectivity; they are effective and much cheaper than traditional methods of calling. These are mostly used by users who are thousands of kilometres apart and benefit a lot from this facility. WhatsApp facilitates voice calls to the extent of group calls.
- Video calls allow online communication and are done virtually, whereby users can see facial expressions, body language and the visual aids employed. This communication can be facilitated by Google Meet, Zoom, WhatsApp and Skype.

In asynchronous communication, a user can leave a message or send a message to be viewed and responded to later. This gives users ample time to reflect on messages and prepare before responding. Asynchronous communication allows broadcasting messages, announcements and feedback for evaluation purposes.

Communication strengthens relationships, keeps users on track by correcting whenever needed and keeps users updated on events.

2.14 Types of SNSs

SNSs have become an integral part of people's daily lives; various types of SNSs accommodate the different needs and interests of users. In this discussion, the thesis delves into the different types of SNSs, their features and benefits.

0. General SNSs: SNSs designed solely for social connection and interactions. They facilitate connection with family and friends, whereby users can share personal updates, events and moments and communicate via text, images, video, audio and any other tool they deem necessary. Examples of such SNSs are YouTube, Snapchat, Facebook, Instagram and Twitter (Mourya and Sharmila, 2017; Calderón-Garrido and Gil-Fernández, 2022).

1. Messaging SNSs: These platforms allow users to send and receive messages in the form of texts, calls and videos. Although there are facilities for attaching other files, these sites are generally known for exchanging messaging content or chatting with friends, colleagues, acquaintances and family. WhatsApp, Facebook Messenger, WeChat, Skype and Snapchat are examples of such SNSs (Oseni, Dingley and Hart, 2018; Jordan, 2023).

2. Professional (business) SNSs: These SNSs facilitate professional connections; these can be used to explore job opportunities, search for prospective employees, build networks, build careers, expand business networks, expand professional networks and share ideas with users in the same profession. Examples of professional SNSs are LinkedIn, 12manage and Hi5 (Hussain, Loan and Yaseen, 2017; Mourya and Sharmila, 2017).

3. Video-Sharing Sites: A playground for content creators, filmmakers, film viewers and event video managers where an array of videos are uploaded for educational, entertainment and informational purposes. On these platforms, users can upload, download and share videos and comment on uploaded videos. Examples of video-sharing sites include YouTube, MySpace and TikTok. These sites are ideal platforms for building an audience and discovering new content (Mourya and Sharmila, 2017; Bartolome and Niu, 2023).

2.15 Summary

In this section, the study provided explanations of the common terms relating to the SNS environment, thereby supplying a basis for what is discussed throughout the research process. This chapter describes the development of the study while expounding on the inquiry into social networking sites. The chapter scrutinises most of the aspects of SNSs by recounting the main functionalities, advantages, limitations, groups of SNSs, their description in general, SNSs as an eLearning tool and their architectures and characteristics. Consequently, ushering in the need for federated social networking sites in a bid to

construct a better eLearning tool for university students. This resulted in a discussion on the types of FSNSs to pave the way for Chapter 5, where the study deliberates on the types of federated SNSs that can be developed.

The exposition in Chapter 2 meets part of the research sub-objective: *To investigate SNSs and provide their comprehensive characteristics*. The subsequent stage of the research delves into an overview of the social networking sites introduced in this chapter by presenting the introductory architecture of the SNSs in general to lay the foundation for the next chapter in which each of the SNSs is explained. In the next chapter, the study answers Sub-Research Question 1, stated at the beginning of this chapter, thereby satisfying its requirements.

Chapter 3 : Overview of Snss

3.1 Introduction

The previous chapter provided the characteristics of social networking sites; therefore, it is important to explore some of the existing individual social networking sites to develop an understanding of their capabilities. Such an understanding guided us toward the development of the proposed federated model as the main outcome of this study. Hence, this chapter is a continuation of the previous chapter, with its main purpose being to achieve the first research objective of the study on the investigation and characterisation of social networking sites. However, Chapter 3 focuses mostly on the study of existing social networking sites in alignment with the characteristics and typology provided in the previous chapter.

This chapter discusses four popular social networking sites in detail since they are used by most students for academic and non-academic purposes (Dafoulas and Shokri, 2014; Al-Dheleai and Tasir, 2017; Ansari and Khan, 2020; Butt, 2020; Wright *et al.*, 2020; Kutu and Kutu, 2022; Tafesse, 2022; Masalimova *et al.*, 2023). The study touches on the background, features and architecture of SNSs to build a background theory of the features and concepts to acquire and use in the development of the FSNS framework.

The chapter is structured as follows: The first section discusses the background and history of Facebook to explore the roots of this SNS platform, highlighting that everything has a beginning. The section also deals with the features of Facebook, which were emulated in the development of the FSNS; further, the section recounts the uses of Facebook, which help to determine whether this SNS is suitable for eLearning purposes; lastly, the architecture of Facebook is examined to guide us in the structure of the proposed FSNS.

The second and third sections provide an in-depth discussion on LinkedIn, YouTube and Twitter, including their backgrounds, features, uses and architectures to guide the development of the FSNS.

The last part of Section 3.2 introduces the development of the FSNS, presenting the model to be used in developing the framework. The three main principles discussed can be used in conjunction with Dubin's first part of the theory development method, which has four stages: (i) identifying the units, (ii) stipulating the laws of interaction, (iii) determining the boundaries of the theory, and (iv) specifying the system states, as discussed in Chapter 4.

3.2 Background and History of Facebook

Facebook is a free social networking platform that helps people communicate more efficiently by allowing users to contact their friends, family and co-workers to share their thoughts, opinions, status updates, photos, videos, links to other sites and any other information they find worthy of sharing. Moreover, social networking sites like Facebook not only allow individuals to keep in touch with their friends but also make new connections and reconnect with old ones. Indeed, Mark Zuckerberg (the founder of Facebook) described Facebook as an online directory that facilitates connections between individuals through social networks at colleges and universities. He contends that the primary objective of Facebook is to explore the various ways in which individuals can connect (Alhabash & Ma, 2017; Aspridis, Kazantzi & Kyriakou, 2013; Ledbetter, 2021; Wu, 2021).

Facebook is a social networking service introduced in February 2004 with a mission to provide individuals with the ability to share and collaborate in building the world. Today, individuals use Facebook to remain connected with friends and family, find out what is happening in the world and share what matters to them. The founder's (Mark Zuckerberg) vision was to assist individuals to share their opinions and communicate with a broad community. The development of Facebook received $500 000 as initial funding from the co-founder of PayPal, Peter Thiel, in 2004. At that time, the company developed Facebook with the idea of linking students at Harvard University only, so the platform only recognised email addresses with the harvard.edu domain. In expanding, the site began to accept other academic email addresses (Brugger, 2015; Alhabash and Ma, 2017; Jiang, Naqvi and Abbas Naqvi, 2020).

In time, Facebook began supporting other tertiary institutions, as students were required to have email addresses associated with their institutions. That requirement kept the site relatively closed and contributed to users' perceptions of the site as an intimate, private community. In 2005, the company granted access to students attending high schools to participate in Facebook social activities. In support of the Facebook extension, Accel Partners invested $12.7 million in April 2005. Thereafter, Greylock Partners and Meritech Capital Partners, combined with Peter Thiel and Accel Partners, invested a further $25 million towards Facebook development and upkeep. In 2006, it opened the site to the public, with an age restriction of 13+ (Boyd & Ellison, 2007; Kraus et al., 2022).

The platform further introduced communities for commercial organisations yet maintained that profiles could not be interchanged at will. At that time, there were many restrictions to friends who had joined universities' social networks because they had to have the (.edu) domain address, and those who had joined corporate networks had to have the (.com) email suffix. In 2006, Facebook was visited by over 2000 United States colleges and ranked seventh of the most popular site on the World Wide Web in the same year.

By 2007, Facebook had more than 21 million registered subscribers, generating 1.6 billion page views each day and by October 2007, the company had reached a user base of 50 million and launched its application platform for mobile users. On the 24th of the same month, Microsoft purchased a 1.6% share

of Facebook for $240 million, which was published to the public, giving Facebook an implied value of $15 billion. As of 29 February 2008, Facebook changed its account deletion policies, allowing users to contact Facebook directly to request that a user account be permanently deleted from the website. Users who do not wish for permanent deletion still had the option of deactivation, whereupon information would be retained on Facebook's servers though not accessible to Facebook users. In January 2009, Facebook was ranked the most-used social network worldwide. Facebook's service is supported through advertisements that appear on every page as pop-ups. Zuckerberg supported advertisements as another primary source of revenue and that Facebook was expected to increase its sales margin by 70 per cent in 2009, during which Facebook became the most popular network compared to its (then) competitor, MySpace, which used to be on top (Edosomwan et al., 2011; Wang, 2013).

In March 2010, Facebook became the most-visited website in the United States, accounting for 7.07% of all U.S. web traffic. That same year in May, Google announced that more people visited Facebook than any other website worldwide. It declared that after findings from 1,000 sites, Facebook had more than 500 million active users by July 2010 and doubled its revenue from $600 million in 2010 to over $1 billion in 2011. As of January 2012, Facebook had more than 845 million active users (up from 600 million at the end of 2010) and accounts for one out of every five page views on the internet worldwide (Infographics Lab, 2012 cited in Buzzetto-More, 2012; Edosomwan et al., 2011; Wilson, Gosling & Graham, 2012).

By June 2012, Facebook had launched its App Centre, which allowed users to find games and other social apps easily, leading to Facebook having 150 million monthly users with 2.4 times the installation of applications. On October 4, 2012, Mark Zuckerberg announced that more than one billion people use Facebook actively each month. For that reason, Facebook became the 'traffic king' of social sites in 2012—the site had become an integral part of users' daily life practices. In the same year, Facebook bought Instagram for $1 billion; the photo-sharing app has more than 400 million users (Magro et al., 2013; Wang, 2013).

A year later, Facebook was still a social networking site giant with a user base of about 1.11 billion subscribers in 2013. Facebook accommodated the highest number of online users globally in January 2014 and was the largest and most popular social networking site on the internet in terms of regular active membership. By March 2014, Facebook had acquired WhatsApp for $19 billion and Oculus for $2 billion, respectively. Because of its incremental growth in terms of user visits and continuous maintenance of the site, the company decided to expand its human resources and, by March 2014, had employed 6,818 workers. In September 2014, Facebook was still the most visited social networking site, with over 1.23 billion people visiting the social network every month, out-performing its competitors by a very wide margin (Duggan and Brenner, 2013; Alassiri, Muda and Ghazali, 2014; Gulati and Sharma, 2014).

Facebook continued to innovate and announced a new feature in January 2015, which allowed users to flag an article they regarded fake; the number of flags would enable Facebook to endorse it as fake. In March of the same year, Facebook opened a new campus in Menlo Park, California. The campus was designed by legendary architect, Frank Gehry, to accommodate more than 2,800 employees. Unfortunately, in 2016 Mark Zuckerberg had to answer difficult questions since Facebook was deemed to have influenced US elections by spreading fake news; still, the company made over $10 billion in profits in 2016, of which the vast majority came through advertisements, with 1.86 billion people logging in every month. In 2017, Facebook made $15.9 billion in profits, a 56% increase in growth from the previous year. In January 2018, Facebook made a substantial change with the introduction of the newsfeed, which required users operating pages on Facebook to pay for advertisements. Thereafter, people spent at least 5% less time on the platform compared to previously. Despite intense competition, Facebook remains the largest and most widely used social network. According to the company's financial statements, as of December 31, 2020, 2.8 billion individuals were using the platform every month (Boyd, 2018; Lirola, 2022; Mukhametgaliyeva et al., 2022; Weinberger, 2018).

3.2.1 Features of Facebook

Currently, Facebook is the most visited website, followed by Google, attributable to its unique features, of which some are common to other networking sites, and others are particular to Facebook only. The site’s popularity has increased since it opened access to everyone over the age of 13; it is also accessible through many mobile devices.

Facebook is an information system used to supply information to users. This information system has three categories: an informing environment, a delivery system and a task completion system. The informing environment that encompasses Facebook's user-friendly interface, makes it easier for all types of users or informers to share information. The delivery system of the Facebook platform ensures that information shared by users reaches its destination by making updates, even to the user’s personal accounts. For example, if a user has not opened their Facebook account, there would be some information on what had transpired during the user’s absence. Lastly, the task completion system of the platform allows users to comment, ‘like’ and add information to what others post (Weinberger, 2018).

In addition, Facebook has many unique features that make it popular beyond several features found on other platforms. Facebook has customisable profiles, privacy and security; its profile privacy settings allow participants to control them, that is, empowering users to decide who can view their basic information (Weinberger, 2018). In that regard, basic information can include users’ profile pictures, profile statuses, personal information, wall posts, education information, work information, mobile phone numbers, current addresses and email, among other features. Importantly, Facebook restricted profile access, that is, if someone would like to view another user’s profile, that particular user must

grant access; requesting such access might happen through the process of "friend requests" and acceptance of the request. In addition, Facebook users have the option to make their profiles public. These features provide all the necessary facilities to maintain user privacy (Al-Dheleai & Tasir, 2017; Alhabash & Ma, 2017; Boyd, 2018; Nyoni & Velempini, 2018; Weinberger, 2018).

3.2.1.1 Photo Album Management

Facebook provides the platform to upload photos into online albums and on their profiles as profile pictures. Although most users now use pictures of what they want, like cars, animals, etc. Profile pictures can be changed at any time. Even though other photo-hosting websites, such as Instagram and Snapchat, exist, Facebook is becoming more popular as it has many more embedded features. The Facebook team responded to the growing desire for users to share photos by introducing a unique feature called *tagging* to images. This feature allows users to label every person and object in a photo. Users can enter into friendship relationships with other registered users and share photo albums that can be linked to the profiles of those present in the picture (Alhabash and Ma, 2017; Marino *et al.*, 2022).

3.2.1.2 Classmates, Friends and Co-Workers Search Engine

Facebook users who belong to one or more networks on the website are part of groups, such as users who attend(ed) the same school, work for the same company or are in the same geographic region or social group, can connect with other users in that same network. Thus the Facebook platform limits the viewing of detailed profile information to users in the same network or who have been confirmed to be friends, depending on the settings selected by a user. In some cases, the content published by a user's friends is visible to each other, which also depends on the user's visibility settings. When a user searches for someone outside their network or friend list, Facebook provides a little information to show that the person exists, which further encourages people to become friends before being able to view each other's profiles (Gulati and Sharma, 2014; Jung and Rader, 2016; Kalelioğlu, 2017).

3.2.1.3 Newsfeed

A newsfeed is an update of what transpires while the user is offline. This feature was initiated in September 2006 and can also be seen by users who provide an alternative e-mail address (Weinberger, 2018). This means that people logged into Facebook with an alternative e-mail address can see such updates. The main reason for this feature is to motivate or lure the user to access the Facebook platform to find out what had transpired in detail. Information sharing via the newsfeed can either be active or passive. The former would be when a user posts content on a wall, and the latter in such cases as interactions with other users, applications or fan pages; thus, the content would be broadcasted to the entire network of the user's friends. In that regard, one broadcast informs an entire list of friends instead of sending it to specific friends one by one.

Facebook also contains the user's updated birthday to remind friends of the pending birthday. When a user decides to make changes to their profile—whether photos or messages—introducing a new topic would appear in the stream/newsfeed of that user's friends. In response, friends would be able to comment on such changes or new content. The newsfeed is best described as a public message board that provides updates on friends' Facebook activities; moreover, it is a focal point of interaction that provides the user with updates on anything concerning their Facebook friends.

3.2.1.4 Applications

Facebook has some applications that allow developers to create widgets to customise user profiles and provide them with additional functionalities. This is the feature that differentiates Facebook from other social networking sites since even outside developers can build applications that allow users to personalise their profiles and perform other tasks, such as ranking movie preference lists. An algorithm, *EdgeRank*, ensures that relevant content appears in the appropriate user's newsfeed. Such newsfeeds are considered objects; thus, when interacting with an object, an 'edge' is created, which includes actions like comments and tags. Furthermore, Facebook has a feature called insight; with this service, Facebook applications avail free data to promoters, allowing them to assess the performance of their advertisements (Weinberger, 2018). In addition, the company created an application called Messenger, which is convenient for sending messages without having to access the main Facebook platform (Helmond, Nieborg, Van der Vlist, 2019).

3.2.1.5 Fan pages

On Facebook, fan pages offer a platform for users with similar interests to interact and engage. For instance, some movies are popular at a given time; consequently, many users would be interested in commenting on those movies. As such, these pages provide discussion walls or forums for topic-specific information in which users can participate (Goyal, 2012). To make a fan page useful, Facebook introduced flags for users to indicate when the information being circulated is false, thereby assisting Facebook in endorsing such information as fake when a story elicits a specific number of flags.

3.2.1.6 Wall

The Facebook platform has a section where friends can write and view public comments by other users. These could be views on certain topics, what has happened in someone's life and so on. These walls are only accessed by users who are confirmed friends, which means users can leave messages on each other's walls—this is seen as proof that they are friends. Friends can comment on posts uploaded on a wall; the comments indicate the date and time they were posted.

3.2.1.7 Groups

Facebook has a facility whereby users can join groups based on common interests, courses, or even inside jokes. In these groups, users can share experiences, research topics, chat or debate with group members. Similarly, members can share pictures and videos, as well as select other members they want

to share their documents with within that group. Some types of Facebook groups allow companies to pay for direct advertising to potential consumers and other interested parties.

3.2.1.8 Timeline

Timeline is a facility in which each user has access to a list of every action they have ever taken on Facebook, and from that list, users can select important status updates, wall messages, photographs or newsfeed items to make public on their timelines. The feature is informative through a collection of text, videos or pictures with date and time stamps associated with each post (Wisniewski, Xu & Chen, 2014).

3.2.1.9 Facebook Connect

Facebook Connect allows users to log into other websites using their Facebook information. For instance, if a user likes an article on a news website, academic site or other social networking sites, they can click a button that would publish the article on their Facebook feed (Gulati & Sharma, 2014). Alternatively, this is an easy way to share crucial information with friends while also being a means of extending Facebook's reach across the internet. In a way, this means that one does not have to look for a web address or URL since the link would be provided on the Facebook platform.

3.2.2 Uses of Facebook

Facebook is a facility that allows users to interact and strengthen old and new relationships. It helps people meet new friends and extend their relationships to (even) friends of friends; it strengthens interpersonal relationships, improves communication, enables social relationships and elicits participation—even with students. Some relationships might have been weakened because of a lack of communication; this situation can easily be rectified through the social networking site by strengthening weak ties. In addition, Facebook provides a platform where users can share resources, ideas, jokes or experiences with their friends, thereby serving as a sort of therapy. Facebook allows users to join virtual groups and organisations created based on similar interests, through which users could meet people with similar interests to discuss or receive updated information. This is necessitated by newsfeeds, the ability to share information, view each other's profiles and post comments on each other's pages.

Furthermore, Facebook offers an application-based system with add-in functions, including online games, virtual farms, virtual pets, the wall and virtual gifts. In addition, the big data portability of the Web 3.0[4] component enables users to fetch information or find data that become transferable across applications and software.

[4] The decentralised web involves a decentralised network and peer-to-peer architecture where users have authority over the generation of their content and transactions and is built on technologies like *blockchain* to provide a more secure and user-centric web experience such that humans and machines comprehend and view web-streamed content from the same perspective (Dimoulas and Veglis, 2023; Gan *et al.*, 2023).

Social browsing is the main usage of Facebook and can be considered an umbrella term for most of the activities on the site. Social browsing can be broken down into social connection, where users will be connected through their social status and what they like would be the mode of their connection. This concept also addresses shared identities, whereby users search for people with similar identities, such as their home town/country, the schools they attended or their profession (Mazman and Usluel, 2011; Spiliotopoulos and Oakley, 2013).

The most popular activities on Facebook are likes and comments. When a user is browsing the social networking site, they are likely to find posts and updates they like or want to comment on. Most people make new wall updates or post content on anything in which they are interested, meaning that their friends might comment on or like such updates.

3.2.3 Facebook Architecture

This section discusses the high-level architecture of Facebook, including a physical presentation of the platform and the software used to develop and support each level of the presentation. Each layer of the Facebook architecture (figure 3.1) is supported by a variety of software tools and technologies to achieve the scalability demands of the platform.

Figure 3.1: Facebook architecture(Barrigas *et al.*, 2014)

The front-end layer offers a swift and responsive service to user requests. Technologies used by Facebook, such as *HipHop*, *Linux*, *PHP* and *BigPipe*, enable the architecture to be scalable and capable of handling high-traffic transmission.

BigPipe loads and renders a page in smaller chunks, enabling the page to appear as fast as possible to users. Although the page takes some time to load, it appears to the user as if the page has already loaded, yet there would only be chunks, as needed by the user.

HipHop translates code (prepared using PHP language) into code prepared using *C++* language; the server would then compile and execute it to enhance the performance of PHP applications. This, in turn, enables Facebook to handle high transmission traffic demands to its platform.

Linux is a highly scalable, open-source operating system that provides a stable and reliable platform that handles high traffic demands in Facebook and executing web applications.

Scribe enables the efficient collection of log data and facilitates the storage of log data from thousands of machines. *Scribe* provides an interface for querying data; the same interface is also used for analysing data. Facebook's infrastructure is easily integrated by the use of *Thrift*, which enables communication between different services on the platform.

Haystack is a highly scalable and high performance photo storage engine that efficiently stores billions of photos from different users of the platform; it handles large amounts of user-generated content. *Haystack* employs memory caching, which frequently allows quick retrieval of accessed photos from memory.

Cassandra is known for high availability and fault tolerance for storing and managing big data in Facebook's multiple data centres. *Cassandra* can deal with massive amounts of data, and its scalability can handle the cumulative demands of organisations' data needs.

HBase is a distributed *NoSQL* database system built on top of *Hadoop* and is designed to deal with enormous amounts of structured data. The system is used in analytics, notifications and messaging, and is designed to withstand high-swift data, can handle large amounts of data and store and process data in real time.

Since Facebook services millions of people throughout the world, the platform has to use a three-tier client-server network that processes user requests, updates applications and also executes tasks per request. A three-tier client-server network refers to requests sent by a client application that does not go directly to the database server but have to go to the server application, which then sends a query to the database server (Patel, 2011).

Facebook was developed by in-house developers with open-source software called *LAMP*, an acronym for *Linux*, *Apache Server*, *MySQL* and *PHP*. Facebook development takes place in a *LAMP* stack and chose *PHP* as its programming language because it has an active developer community that helps Facebook fulfil its endeavour of facilitating instant updates on the website, with the philosophy of "build quick, change quick and iterate" (Patel, 2011). Furthermore, the application uses *C++* and *Java*, which are very robust and efficient. A framework that enables cross-language development known as

Thrift was developed. *Thrift* supports over 15 languages which include *C++*, *C##*, *Java*, *Python*, *Ruby*, Erlang, *Perl* and *Hack*, among others. The protocol also allows for scaleable and efficient communication between services coded in different languages (Gulati and Sharma, 2014; Weinberger, 2018).

The application chooses the appropriate programming tool for the service under development. Facebook uses *MySQL* as a database because of its reliable speed, which manages as many thousands of processes as Facebook needs at a given time. Furthermore, the database has many memcaches that a client-server network uses to alleviate the load of the database. Facebook has also developed a Service Management Console (SMC) that assists in discerning which server is being used at a particular time for a specific service since the platform utilises many different servers (Patel, 2011; Gulati and Sharma, 2014).

Besides memcaches, the Facebook application has leaf servers that store data and actions about users' friends. When a user accesses their home page, all their friends' global IDs are passed on to the aggregators. The aggregators send the query in parallel to the leaf servers, which filter out the data on different pre-programmed metrics and return the data to the aggregators, which, again, apply a high level of filtering and specific metrics, generating a final ranking of actions to display on the newsfeed. Facebook designed view state storage that ensures actions displayed an hour before are not repeated to alleviate load (Mazman and Usluel, 2011; Patel, 2011).

3.3 Background and History of LinkedIn

LinkedIn is a social networking site for people in professional occupations, connecting talent with opportunity. It allows business owners, entrepreneurs, professionals and prospective employees to connect and search for contacts either by expertise or location. LinkedIn was created in the living room of co-founder Reid Hoffman in 2002 and then launched officially on the 5th of May, 2003, as a networking site for professionals to connect virtually without having to meet physically. The founders include Reid Hoffman and executives from PayPal and SocialNet.com. Their main focus was to enable the professional community to create networks with co-workers and other business associates. The company's headquarters are located in Mountain View, California, with other offices in Amsterdam, Bangalore, Beijing, Chicago, Dubai, Dublin, Graz, Hong Kong, London, Los Angeles, Madrid, Melbourne, Milan, Mumbai, Munich, New Delhi, New York, Omaha, Paris, Perth, San Francisco, São Paulo, Shanghai, Singapore, Stockholm, Sunnyvale, Sydney, Tokyo, Toronto and Washington DC. (Al-Badi *et al.*, 2013; Jensen, 2013; Cooper and Naatus, 2014; Hoffman *et al.*, 2016).

LinkedIn's mission is to connect the world's professionals to make them more productive and successful. Further to that, its vision is to create economic opportunity for every member of the global workforce, showing great acceptance by reaching around 4500 subscribers by the end of its first month

of operation. LinkedIn has more than 467 million subscribers and more than 10,000 full-time employees. It is available in 24 languages: Arabic, English, Simplified Chinese, Traditional Chinese, Czech, Danish, Dutch, French, German, Indonesian, Italian, Japanese, Korean, Malay, Norwegian, Polish, Portuguese, Romanian, Russian, Spanish, Swedish, Tagalog, Thai and Turkish (Hoffman *et al.*, 2016; LinkedIn Corporation, 2016).

LinkedIn generates revenue from:

i. Talent Solutions (63% of its revenue), which include recruiting tools and online education courses.
ii. Marketing Solutions (19% of its revenue), which allow individuals and enterprises to advertise to LinkedIn's PSN members.
iii. Premium Subscriptions for both consumers and businesses (18% of its revenue).

In 2004, LinkedIn introduced a new feature, groups, and partnered with American Express to promote its offerings to small business owners. The following year, the company launched its premium service for recruiters and researchers. LinkedIn introduced its first business lines, i.e., jobs and subscriptions, to boost its revenue, and in that year, the company also moved into its fourth office. In 2006, the company launched public profiles, a professional profile of record, and introduced core features like recommendations and people known to participants (Jensen, 2013; Cooper and Naatus, 2014; Microsoft, 2016).

In 2007, the CEO, Reid, stepped aside, bringing in Dan Nye to lead the company. In that same year, LinkedIn moved to Stierlin Court and opened its customer service and sales centre in Omaha. In 2008, the company opened its first international office in London and launched Spanish and French language versions of the site. The organisation further launched the LinkedIn Audience Network, allowing advertisers to target their marketing efforts more closely. At the end of 2008, Dan Nye left LinkedIn, and Reid returned as CEO. At the same time, Jeff Weiner came aboard as President and Deep Nishar joined as VP of Products. Later that year, Jeff Weiner became CEO, and Reid remained as Chairman.

In 2009, the company opened its first office in Mumbai. The new CEO brought focus and clarity to LinkedIn’s mission, values and strategic priorities. In 2010, LinkedIn had 90 million members and approximately 1,000 employees in 10 offices globally. It also acquired ChoiceVendor, a company offering real-world ratings of business-to-business (B2B) service providers in the US and also acquired mSpoke, a recommendation technology for making content more valuable (Cooper and Naatus, 2014; Hoffman *et al.*, 2016).

On the eighth anniversary of LinkedIn in 2011, the organisation became a publicly traded company on the New York Stock Exchange. More conveniently, the application was now available on most smartphone platforms while adding another language (Japanese) when opening offices in Tokyo and a technology centre in India. In the same year, the company successfully acquired CardMunch Inc., a

privately held California-based provider of mobile business card transcription services. In February 2012, Rapportive, a contact management service providing a plugin for Gmail displaying social network updates from users' correspondents, was acquired by LinkedIn for $15 million. The company also acquired three more companies, namely SlideShare, Esaya and Mumbo, which helped the business add talent, technology and product to assist in accelerating its strategy (Al-Badi *et al.*, 2013; Jensen, 2013).

A new feature, Endorsements, was introduced, which facilitated the recognition of a connection's skills and expertise, thereby endorsing them. During that year, more languages were added, making a total of 19 languages; furthermore, an iPad application was introduced with the aspiration to become the platform every professional accessed throughout the day. On October 2, 2012, LinkedIn launched Influencers, the ability to follow more than 150 most influential thought leaders on LinkedIn, who would share unique knowledge and professional insights (Sharma and Datta, 2012).

In 2013, LinkedIn launched a feature for members to add rich media content to their profiles, helping them to tell their professional stories more visually. LinkedIn further acquired Pulse, which had the core value of helping to foster informed discussions that spark the decisions shaping the world through news and information. A new feature called LinkedIn Contacts was also introduced; this feature could operate both on computers and iPhones as an application. As the organisation celebrated its 10th year of operation, the company reached 225 million members. In 2014, SlideShare, a tool enabling users to share presentations, media and content on relevant topics, became a new mobile application for content. The company further purchased Bright (a job-matching service), Bizo and Newsle and added more offices in a bid to expand its global presence (Hoffman *et al.*, 2016).

The following year, LinkedIn acquired lynda.com to make it even easier for professionals globally to accelerate their careers and realise their potential by learning and developing new skills. In that same year, the company's revenue reached approximately $3.0 billion, a growth of 35% year-on-year. In an opening letter of the document LinkedIn Corporation Form 10K, Jeff Weiner emphasised that they would follow three key themes in 2016. First, there was a need for a continued focus on core products. Second, deepening the value exchanged between members and customers. Lastly, pursuing intelligent growth through increased ROI discipline. On 11 June 2016, Microsoft and LinkedIn signed an Agreement Plan of Merger, by which Microsoft acquired all the shares of LinkedIn (Hoffman *et al.*, 2016; LinkedIn Corporation, 2016; Microsoft, 2016).

3.3.1 Features of LinkedIn

LinkedIn is a social networking platform meant for professionals to network, share professional advice, read blogs, and gain work-related insights and tips. It also allows companies to follow other organisations they find interesting. Users of LinkedIn can create professional profiles and should make sure their profiles are attractive to potential employers. As such, these profiles, if accompanied by

endorsements and recommendations from colleagues, professors and supervisors, would provide a positive picture to those who would view the profile. There is also a public profile, which can be viewed by many users who might be potential employers, colleagues or other connections. Ultimately, this increases the number of connections and expands the network, thereby increasing the probability of growing a career or finding the next job (Cooper and Naatus, 2014; Hoffman *et al.*, 2016; LinkedIn Corporation, 2016; Vuorelma, 2018).

Companies have since adopted the LinkedIn platform to transmit information about their offerings. A company profile should, therefore, contain information such as what the company does, the location of its offices, the number of employees, the industries within which they operate and the jobs on offer.

The sections to follow contain a discussion of some of the features of LinkedIn. Such features may either fall under the free offerings of the platform or the monetised solution.

The free solution has three options, as described below:

i. Stay Connected and Informed: Enables users to get in touch and connect with other professionals, participate in online discussions and stay versed with updates in the industry.

ii. Advance My Career: Offers tools that showcase users' professional profiles and will be able to search for job opportunities. LinkedIn learning allows users to develop new skills through research and development.

iii. Ubiquitous Access: LinkedIn can be accessed from anywhere and at any time. Users are free to use either a mobile app or a website to access the platform.

The monetised solutions are further divided into:

i. Talent Solutions: LinkedIn provides users with tools for companies that want to recruit or find top talent / the most skilled persons available. The facility provides access to candidate search, job postings and employer branding.

ii. Marketing Solutions: Advertising and marketing tools are provided to reach LinkedIn's professional audience. Marketing solutions include sponsored content, display advertisements and lead generation.

iii. Premium Subscriptions: Enable users to access enhanced features for LinkedIn users who have reached a certain level of subscription. These features include access to premium insights, messaging tools and advanced search filters.

iv. Learning and Development: Provides learning on an online platform with a variety of courses and learning tools that help individuals to develop different skills and further their careers.

3.3.1.1 Groups

LinkedIn Groups allows users to express their status in a professional context; this aims to keep users up to date with the information appropriate to the areas they would have provided. Groups provide a forum for members to discuss topics of interest and meet and interact with other professionals who share those interests and have opinions and domain expertise in specific areas. In addition, LinkedIn groups are the perfect way to build an engaged community on the world's largest professional platform. Group members meet to discuss issues concerning their careers, share links to other connections and comment on issues raised in that group (LinkedIn Corporation, 2016; Fallah, 2018).

3.3.1.2 SlideShare

SlideShare enables users to share slides of presentations via the platform. LinkedIn users, or even ordinary viewers, can share PDF documents, videos and webinars. SlideShare is the world's largest professional content-sharing community. Since SlideShare was already part of many users' professional identities, it was wise for LinkedIn to add this feature since it could also showcase brilliant ideas through projects and research work (Loof, 2014; LinkedIn Corporation, 2016; Fallah, 2018).

3.3.1.3 Pulse

Pulse enables LinkedIn members to be better informed in their everyday jobs by showing them relevant news collected and organised by the members of their networks and fellow professionals in their industries. Its main purpose is to collect information from influential industry professionals and businesses, which is then used to generate news, blog posts and insights; this information is availed to individual users according to their interests. Pulse notifies users about what content is endorsed for them, making that content more relevant and personalised to the user. The Pulse application allows users to organise channels into topics of choice, such as Technology, Sports, Favourites or Must Reads (Hoffman *et al.*, 2016; LinkedIn Corporation, 2016, 2017).

3.3.1.4 Native video

The native video feature allows users to customise video by adding an element of visual storytelling and a personal touch to their business while always remaining professional. This feature is also found on mobile applications; its duration is between three seconds to 10 minutes, and the maximum file size to be sent is 5GB. Furthermore, there is an allowance of up to 700 characters of text that can accompany the video. Another amazing feature of native video is that users can tag people in the video updates (LinkedIn Corporation, 2017; Fallah, 2018).

3.3.1.5 Advanced Search

Advanced search enables users to search by location, current companies, past companies, industries, profile languages, non-profit interests and schools. Users can even look for first-, second- and even third-level connections if need be. By its very nature, the feature helps the user by highlighting all the relevant matching contents gathered from different categories. Thus, the feature is very helpful as

hundreds of millions are using LinkedIn on the continent. Advanced search would help in screening members who are of special interest. In addition to users that can upgrade to LinkedIn's Premium Sales or Hiring Plans, some features such as *function* and *years of experience* can be accessed (Fallah, 2018).

3.3.1.6 Messaging

LinkedIn has a live chat option like Facebook, whereby a user can discern who is online for a chat when a user's icon is accompanied by a green button, helping connections to see when someone is available. In that sense, when a user is expecting real-time conversations, they may take advantage of the green button. The messaging feature additionally allows users to message directly from the homepage without having to click through each individual profile to find the message option, making it very easy and fast to make connections. The application arranges the messages in such a way that enables easy reference for the last message to be received or sent to be at the top of a thread for easy identification. Further, members receive notifications via emails, which also makes it easier for users to find their messages faster and easier (LinkedIn Corporation, 2016; Fallah, 2018).

3.3.1.7 Recommendations

The Recommendations feature is a testimonial with which a user could recommend a former employee, current employee, classmate or lecturer for good professional work during their engagement. For that matter, it is usually done to help users get connections or expand their connection list. As such, these recommendations can be requested by a user from colleagues, who may write a recommendation without a request. A recommendation should describe a user's job experiences or project functions roles to unpack the user's capabilities. The feature encourages users to obtain a wide range of recommendations, yet ensuring they are from reputable people to avoid tarnishing a user's image (Patel, 2011; LinkedIn Corporation, 2017; Fallah, 2018).

3.3.1.8 Customised Notifications

The Customised Notifications feature allows users to receive timely updates on activities pertaining to their personal connections. This could enable users to initiate conversations, thereby increasing opportunities for new careers or upgrades and also allowing users to select what is relevant to their lines of business or study. However, notifications can be turned off and muted, or the user can unfollow anything deemed irrelevant without losing existing connections. The main advantage of customised notification is that a user may not necessarily follow every article shared by the user's connections but only see exactly what the user intends to see at that moment. More so, there is also the availability of a rundown notification of the top news. These are summarised to keep users updated with the latest news. The search appearance is another feature that appears weekly, notifying the user of how many people have found a user through a LinkedIn search (Loof, 2014; LinkedIn Corporation, 2017; Fallah, 2018).

3.3.1.9 InMail

InMail is a LinkedIn feature used by users with a Premium account. It is considered an excellent resource that allows users to send private messages to anyone on LinkedIn. This feature can be used by enterprises and professional organisations to send direct messages to potential candidates or advertise upcoming opportunities. The InMail analytics page shows detailed information on the messages sent for the data they contain to be used in future, even for improving how messages are sent (LinkedIn Corporation, 2016; Fallah, 2018).

3.3.1.10 Lynda

This is the online learning website acquired from Lynda.com and available on LinkedIn's homepage. LinkedIn took advantage of Lynda.com's easy-to-access expertise and combined it with its complex database to enable users to discover and learn from many subject areas quicker and easier. Members who subscribe can learn from experts at anytime and anywhere. Importantly, the website provides a full video training library indexed by subject, software and new releases. That means subscribers can sync course history across all their devices, stream courses directly to their TVs, auto-play entire courses, or watch individual videos. Users can share courses across social networking apps, edit and view playlists and download or view full courses offline (LinkedIn Corporation, 2016; Fallah, 2018).

3.3.1.11 Analytics

A feature that is meant to give the users a view on their performance for instance within a company or in an educational environment, aimed at making improvements accordingly. Analytics enables users to see the number of views, likes and dislikes of their posts. As well as comments and shares left by other connections, whilst it also helps the user to focus on the type of content mostly liked by their connections (Loof, 2014; Fallah, 2018).

3.3.1.12 University Pages

University Pages provide students, prospective students and alumni, access to insights and information from thousands of universities globally. University can give updates on the activities on the campus or even notices to their current students and Alumni. Furthermore, it provides the tools for ranking universities, measuring them according to the careers of their alumni and what they had achieved. There is also a tool known as university finder which helps the users to view the most attended schools for specific careers. The users may then make the most valuable decisions after they got that information (LinkedIn Corporation, 2016).

3.3.2 Uses of LinkedIn

Unlike other social networking sites like Facebook and Myspace that focus on personal networking, LinkedIn is regarded as a powerful networking platform for professionals to initiate and maintain relationships; some users utilise it for advertising, managing sales and also recruiting (Branden *et al.*, 2011). The most valuable purpose of LinkedIn is to find connections with the right people. This

platform even helps people track down friends from high school or college and reconnect with them, especially if they are in the same line of work. By searching for connections, users can discover information that could help with conversations, meetings or network events (Loof, 2014). The facilities offered by messages and the premium InMail helps users to maintain relationships by sharing ideas with a network.

LinkedIn recommendations aid users with becoming visible so that when there is a need for a person with particular skills, the user would be readily available. In that regard, referrals are important to shaping a career (Branden *et al.*, 2011). LinkedIn can also help to raise a user's visibility and reputation. This can help users find online professional groups to join consisting of people at the same professional level or in the same location, age or educational background (LinkedIn Corporation, 2017).

Essentially, LinkedIn offers an online recruitment service that aids in hiring decisions by employing a screening and recruiting method mostly used by recruiting experts on LinkedIn (Microsoft, 2016). Users can take advantage of the growth of LinkedIn and search for jobs in a wider market. Due to the option of recommendations and referrals, looking for employment becomes easy because the employer could scrutinise a profile to ascertain if someone is fit for the job.

Another purpose of LinkedIn is research; professionals share ideas and data in their groups, therefore becoming opportunities for researchers to gather all relevant data on a given situation. Students can also share ideas and search for tutors to assist in their studies (Branden et al., 2011). Research on LinkedIn is not limited to scholarly research; as such, users can research to find out more about the organisations of interest.

3.3.3 LinkedIn Architecture

LinkedIn is designed to be scalable, reliable and efficient, allowing the platform to support millions of users and billions of interactions each day. The architecture is divided into three distinct tiers to ensure that each layer is optimised for its specific function and that changes or updates in one layer do not cause unintended consequences in another layer. The section below discusses the LinkedIn architecture.

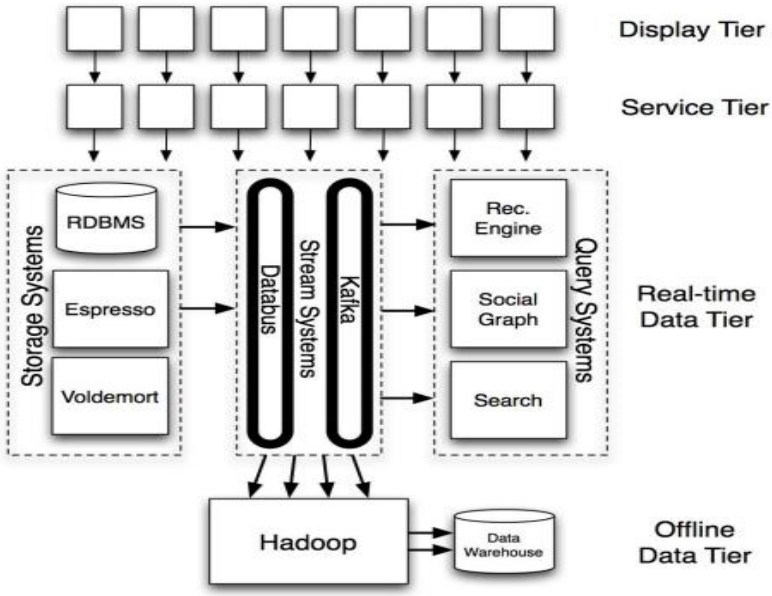


Figure 3.2: LinkedIn architecture (Auradkar *et al.*, 2012)

Like Facebook, LinkedIn is serviced by a three-tier client-server architecture because the site has millions of users, albeit mostly professionals. The data tier is responsible for storing and managing all user data associated with LinkedIn, including profile information, job history, connections and other relevant data points. The service tier provides an interface for interacting with data through the LinkedIn API, which allows developers to access and manipulate user data in a secure and controlled way. The display tier is responsible for rendering this data in a user-friendly way through the LinkedIn website and other user-facing applications like mobile apps or third-party widgets. Unlike Facebook, LinkedIn is written in *Java* except for a few services. The technical architecture of LinkedIn can be narrowed down to two main aspects, namely the LinkedIn communication system and LinkedIn network updates system. The communication system is responsible for such functionalities as email and profile, while the network updates system is more like an *RSS* newsfeed (Patel, 2011).

3.3.3.1 LinkedIn Communication System

This system services the permanent message storage function, whereby every user is allocated a fixed amount of storage space for messages directed to that user. The system also manages the email facility, which contains content or messages from other users or friends that remain in storage unless the user deletes them. Additionally, there is batching of delayed delivery mails, as well as the facility for bouncing or cancelling requests for connections. Even users who want to withdraw their connections are also handled here. Messages that require action to verify identity are handled by a feature called actionable content, which also enables rich email content that handles email text with attached images or data (Branden *et al.*, 2011; Patel, 2011).

The communication service is further divided into two categories, message creation and message delivery; each service plays a different part in fulfilling the functions of communication service.

i. Message creation: The client sends messages via the asynchronous *Java* Communications API using JMS. The messages are then received by a component called the Comm Dispatcher, which examines, processes and extracts a list of recipients. The Comm Dispatcher then passes the message on to the Comm Router, which, in turn, sends it to one or more backend delivery services.

ii. Message Delivery: After the Comm Router passes on the message to one or more backend delivery services, the Comm Deliver component examines the Inbox Guest DB or Inbox Member DB for all messages created by the user. It then packs these messages into a single JSP message and passes it on to the Notifier component. The Notifier component runs the JSP engine to format the message, apply templates and prepare it for delivery. The message is then sent to Simple Mail Transfer Protocol (SMTP) gateways for delivery. In case of message delivery failure or bounce-back, the SMTP gateways communicate with the Comm Dispatcher. Bounced messages are processed and redelivered if necessary.

3.3.3.2 LinkedIn Network Updates Service

The service fetches the updates from different connections based on rankings. LinkedIn has 15 main titles for the LinkedIn network updates service. They are displayed on the user's homepage when notifying them. The target is to have flexible service for distributing 15 types of short-lived updates. These remain on the screen for an allocated time interval after it is updated, thereby providing many updates to the end user (Patel, 2011).

3.4 History and Background of YouTube.

Former PayPal employees, Chad Hurley, Steve Chen and Jawed Karim founded YouTube at a dinner party in San Francisco; Chad Hurley registered the YouTube trademark, logo and domain on Valentine's Day, 2005. At that time, it was set up as a platform for amateurs to upload and send videos online, although it has since transformed into an established entertainment industry sharing website where most people spend their time uploading, downloading, viewing, and even commenting on videos. Moreover, content creators also have found job opportunities in mainstream media. The site commenced with a venture capital investment of 11.5 million investments and grew to 100 million videos per day, where these millions of video clips represent a broad spectrum of entertainers, educators and researchers' interests (Alias *et al.*, 2013; Braun *et al.*, 2017; Holland, 2017).

In October 2006, Google acquired the YouTube site for $1.65 billion. Since then, it has steadily gained popularity and, in 2008, was recorded as one of the top ten most visited sites globally. Its number of professional productions started to increase; since then, its content-generated channels have increased by 20%. From the time it was purchased by Google, YouTube moved from a site for amateurs to an online platform populated by commercial and professional videos. Later, it was ranked as the third most

popular online platform with 61 languages and million advertisers in the world (Holland, 2017; Bärtl, 2018).

YouTube has been recognised as one of the most competitive services aiming to remove technical barriers to pervasive video sharing online. In 2010, it was classified as the third most visited website, and in that year, the company created a new feature designed to simplify the interface to increase the time users spend on their site. The website provided a very simple yet integrated interface within which users could upload, publish and view streaming videos without high levels of technical knowledge. In the same year, YouTube removed the 'Broadcast Yourself' slogan from its home page and assigned the title of content creators to users rather than them being mere broadcasters (Holland, 2017; Hou, 2019, p. 538).

When Google purchased YouTube, within a short space of time, the application was turned into an income-generating platform with a business model focused on advertising. YouTube receives a large portion of its income from advertisements, which is used to fund its activities, including the continual improvement of its platform. YouTube also adopted a new e-commerce model by placing banner ads in videos or on YouTube pages and sharing the revenue with the copyright holders of the videos. The basic idea of selling banner advertisements is to play commercials during video streaming (Braun et al., 2017; Kim, 2012; Schwemmer & Ziewiecki, 2018).

3.4.1 YouTube Features

YouTube features include a wide variety of content, including movies, movie trailers, TV clips, music videos and advertising videos, as well as amateur content such as video blogging and short original videos. These can be watched by registered and unregistered users, although unregistered users are limited to viewing only some videos, whereas registered users can upload and download an unlimited number of videos. Below are the specific features of YouTube this study identified (Holland, 2017; Hou, 2019).

3.4.1.1 Comments

The SNS implemented a ranking system that reduces the number of 'dislikes' from viewers and reduces negative and spam comments. The ranking facility in the comments section can analyse various factors like the engagement date, the history of the user who had submitted a comment and the number of dislikes and likes a user has. Among other tools introduced by YouTube are moderation tools, with the capability to remove inappropriate or offensive comments from videos (Hou, 2019).

3.4.1.2. Subscriber Notifications

This feature is used by content creators to alert their followers when they upload new videos on the platform. This option is developed in such a way that the notifications can either be received via email

or mobile phone messages. Subscriber notifications are very important to content creators with large followings because of their ability to reach a wider audience, resulting in more views (Holland, 2017).

3.4.1.3. New Types of Cards

Promoting content is an effective way of ensuring that YouTube retains its current users and also increases the number of new viewers. New cards were introduced for content creators to promote their channels, sell merchandise and raise funds. These types of cards are:

- Channel card: Creators can link and share their videos with other channels to increase visibility on the platform, thereby growing their audience.
- Video or playlist card: This is used to promote specific videos and playlists to viewers.
- Donation card: A facility to raise funds for charitable or personal use and projects.
- Merchandise card: Allows users to advertise and sell branded products directly from their videos (Schwemmer & Ziewiecki, 2018).

3.4.1.4. Easier Access to the Subscription Feed

The subscription feed feature enables content creators to trace their fans' attempts to view their content. YouTube designed a mobile application that allows the subscription feed and other updates to reach creators faster. With mobile applications, content creators can view updates from their subscribers, see the number of views and access their subscription feeds. Creators can respond to their viewers' comments, building a strong bond and probing the reasons for certain comments, thereby increasing effectiveness (Hou, 2019).

3.4.1.5. A Faster, More Useful Creator Studio Application

With the usage of mobile devices continually increasing as the preferred medium for consuming video content, YouTube added improvements to the Creator Studio application. These additions provided content creators with more analytics tools with which to gain valuable insight for making informed decisions on how better to interact with their viewers and optimise their channels. The application offers added features that enable creators to interact with their audiences and take action on important events, for example, the performance of the video on the application (Braun et al., 2017).

3.4.1.6. Video Management on the Go

The YouTube team designed a facility that enables users to update their custom thumbnails from their mobile devices since the use of mobile devices is increasing daily. Another feature of video management is the ability to enable or disable the monetisation of videos, which the content creator can do from anywhere using the mobile app. Consequently, content creators do not have to be in a studio or use a computer to manage their monetisation (Alias *et al.*, 2013).

3.4.1.7. 360-Degree Videos

New video-capturing devices such as GoPro and drones are the order of the day, allowing the recorded video to produce a 360-degree view for viewers to see the best angle of where the video is being taken. These videos have become popular with activities like sports, live streams, travel and adventure. A 360-degree video provides a fascinating and excellent viewing experience that is vastly superior to traditional videos because all angles of the environment being filmed are captured (Braun et al., 2017).

3.4.1.8. Better Live Streams

Videos, entertainment, gaming and learning have become part of the YouTube delivery system. Thus, it has enabled content creators to easily set up and manage live streams of all kinds. Another feature of live streams is the availability of an option to add a chat moderator and produce real-time polls and quizzes, thereby encouraging collaboration and engagement and enabling content creators to build strong connections with their viewers (Schuck *et al.*, 2022).

3.4.1.9. New Creator community

The creator community is an online forum developed to encourage collaboration, share advice and provide the company with feedback on how to improve products and services. It facilitates space for creators to connect, discuss common challenges, and share expertise and ideas on how to manage their subscribers and content creation (Braun et al., 2017).

3.4.1.10. Updated Creator Academy

The internet has undeniably democratised education. Users from around the world can now access free classes from the best universities in the world. The feature facilitates a wide range of tutorials, courses and classes facilitated by video production, audience engagement, monetisation strategies and marketing. The academy facility is free to access and offers a comprehensive curriculum with constant updates about the latest trends and industry innovations. This facility is available to all content creators regardless of their experience (Gbolahan, 2017).

3.4.1.11 Flagging Features

This feature is used to highlight inappropriate content and that users generally do not like on YouTube. Thus, flagging enables the highlighted content to be submitted for review by YouTube staff. If the content is not supported by the guidelines for YouTube policies and safety, it can be removed or disabled. Examples of content that can be flagged include graphic violence, hate speech, harassment and nudity (Braun et al., 2017).

3.4.2 Uses of YouTube

Billions of people around the world discover, watch and share originally-created videos owing to YouTube. With that in mind, the platform provides tools to connect, inform and inspire people across the globe by providing a distribution platform for original content creators and advertisers. When a

platform is being developed, some objectives are intended to be fulfilled, and their uses are spelt out, but as time moves on, some unforeseen yet important uses are discovered (Braun *et al.*, 2017).

3.4.2.1 Education

Videos can be a powerful educational and motivational tool. YouTube is proven the best platform to support students since students have become more accustomed to using digital technology such as blogging, online text messaging and other internet-based media. YouTube EDU permits colleges and universities to establish customised channels through which they can share video-recorded lectures and events happening on their campuses. The resources needed to use the YouTube facility are already present in a setup where the internet and projectors are already present, making it a low-cost investment. For instance, in a seminar or online class, Youtube can be used to view a video of a guest speaker who could not be physically present for various reasons. YouTube can be used to create a virtual learning classroom in which everyone can contribute, comment and rate the value of the content presented and benefit from the learning process. The advantages of learning through videos are the portrayal of concepts involving motion and the alteration of space and time, the observation of dangerous processes from a safe vantage point, the dramatisation of historical or complex events and the demonstration of sequential processes the viewer can pause or rewatch (Alias *et al.*, 2013; Gbolahan, 2017; Abed, 2019; Mukhtar *et al.*, 2020).

The use of YouTube as an educational tool offers several benefits, including the incorporation of positive attitudes, increased learning control, improved reading and study behaviour, and enhanced student performance. It provides the opportunity to create a virtual classroom, where students can contribute, comment, and rate the value of the presented content. The use of videos as an educational tool offers several advantages, including the ability to portray concepts that involve motion, changes in space and time, and the observation of potentially dangerous processes in a safe environment. Videos can also be used to dramatise historical or complex events, as well as demonstrate sequential processes that can be paused and rewatched by the viewer (Paul A. Soukup, 2014; Gilbert, 2015; Kuimova, Kiyanitsyna and Truntyagin, 2016; Gbolahan, 2017; Dhawan, 2020; Mukhtar *et al.*, 2020)

3.4.2.2 Entertainment

A YouTube channel generally keeps track and manages a record of users who view the videos and also provides a platform which helps creators enrich their activities and devise improved, competitive ways of producing content. These media allow content creators to refine, augment and transform their craft. Content consumers then download refined content for entertainment, either in the form of videos or audio (Arslan and Zaman, 2014; Holland, 2017; Zanatta, 2017; Möller *et al.*, 2019).

3.4.3 YouTube Architecture

Figure 3.3 below shows a diagrammatical representation of YouTube followed by a discussion.

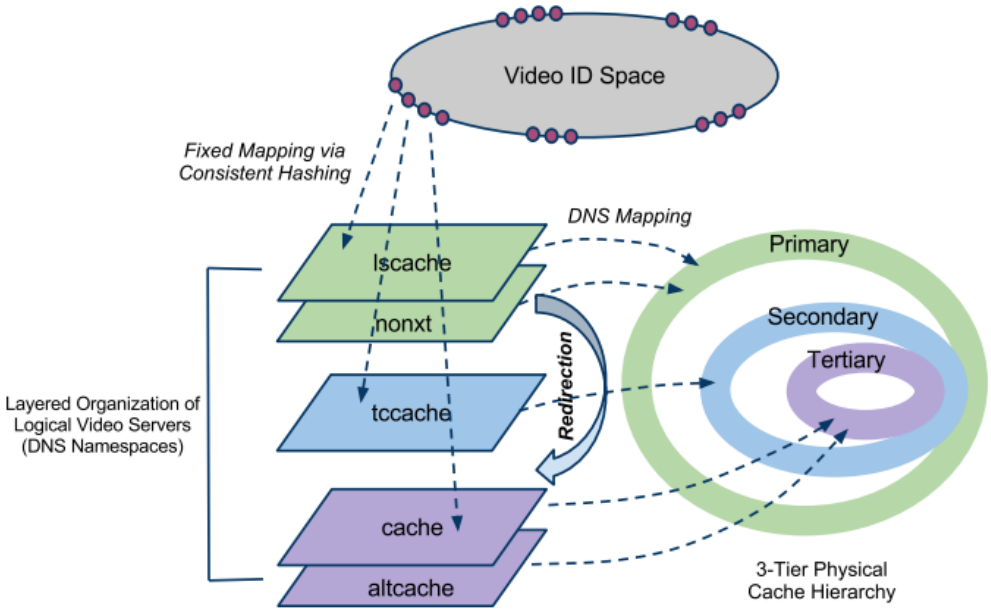


Figure 3.3: YouTube architecture (Adhikari *et al.*, 2012)

As with the other two SNSs (Facebook and LinkedIn) discussed previously, YouTube has a three-tier physical server cache hierarchy with at least 38 primary locations, eight secondary locations and five tertiary locations as part of its video delivery system. The other two recorded are the video ID space and the multi-layered organisation of multiple anycast DNS namespaces representing logical video servers. Users access the website and watch videos on the YouTube website equipped with an *Adobe Flash Player* plug-in. These videos are streamed from an individual YouTube Flash video server separate from the YouTube web servers. The four steps executed are:

i. The HTTP GET a request to download a video.

ii. HTTP reply containing the basic HTML page containing the URLs to download other components, including flash video file.

iii. HTTP GET a request to download a flash video file.

iv. HTTP REPLY with a flash video file.

Whereas i and ii communicate with the front-end web server, iii and iv communicate with the front-end video server. Torres et al. (2011, p. 2) describe the steps in a simpler form:

i. When accessing videos from the YouTube site at www.youtube.com, the user either browses the portal-based system looking for the desired content or accesses the video web page directly by following a video page URL.

ii. Until the video web page is accessed, mostly static information and small thumbnails of suggested videos are presented. Once the video has been selected, the front end replies with an HTML page in which the video is embedded using an *Adobe Flash Player* plugin that takes care of the download and playback of the video.

iii. The content server name is resolved to an IP address by the client via a DNS query to the local DNS server.

iv. Finally, the client will query the content server via HTTP to receive the actual video data.

These servers are found in the YouTube video cloud; the DNS server will be there to support the user with YouTube hostnames and other hostnames of the YouTube servers. Each video is identified with a unique ID, which is the 11-literal string after v of the whole URL (Torres *et al.*, 2011; Adhikari *et al.*, 2012). Adhikari et al. (2012, p. 3) provide an example of the URL: « http://www.youtube.com/watch?v=tObjCw-WgKs » where tObjCw-WgKs is the video ID.

The components of the video delivery system are a flat video ID space, a multi-layered logical server organisation and a three-tiered physical cache hierarchy.

3.4.3.1 The YouTube Video ID space

Each YouTube video is uniquely identified with a flat identifier of 11 literals long. The literals in the first 10 positions can be one of the following 64 symbols; {a-Z, 0-9, -}. Only 16 of the characters appear in the 11th position of which one of the characters is nil, while the other 10 positions have an almost evenly distributed appearance of those 64 characters in the video ID space (Adhikari *et al.*, 2012, p. 8).

3.4.3.2 Three-tier (Physical) Server Cache Hierarchy and their Locations.

YouTube has a three-tier physical cache hierarchy with (at least) 38 primary cache locations, eight secondary and five tertiary cache locations. About 10 of the primary cache locations are co-located within ISP networks, which are referred to as non-Google cache locations. Each location in the hierarchy contains a varying number of IP addresses and "there are *(sic)* some overlapping between the primary and secondary locations" (Torres *et al.*, 2011; Adhikari *et al.*, 2012, p. 6).

3.4.3.3 Multi-Layered Anycast DNS Namespaces

YouTube videos and the (physical) cache hierarchy are tied together by a set of (logical) anycast namespaces as well as unicast namespaces. There are primarily five (anycast) DNS namespaces that YouTube defines and are organised in multiple layers, where each layer represents a collection of logical video servers with certain functions carrying a specific format. These logical video servers are mapped to the IP addresses of physical video servers residing at various locations within a particular tier of the physical cache hierarchy. Of those five namespaces, two namespaces contain 192 DNS names representing 192 logical video servers mapped to the primary cache locations. One namespace also contains 192 DNS names representing 192 logical video servers mapped to the secondary cache locations, and the last two namespaces contain 64 DNS names representing 64 logical video servers mapped to the tertiary cache locations in the YouTube physical cache hierarchy (Torres *et al.*, 2011; Adhikari *et al.*, 2012).

3.4.3.4 Unicast Namespace

YouTube has a unique unicast DNS hostname, a one-to-one mapping between this hostname and the IP address. These unicast hostnames have two formats referred to as the *rhost* and *rhostisp* (unicast) namespaces, whereby the *rhost* namespace covers the IP addresses (physical video servers) residing in Google cache locations, and the *rhostisp* namespace covers those in non-Google cache locations. Only the hostnames belonging to the *LSCache* namespace are generally visible in the URLs or HTML pages referencing videos. DNS names belonging to the other four anycast namespaces as well as the two unicast namespaces occur mostly only in the URLs used in dynamic HTTP request redirections during video playback (Torres *et al.,* 2011; Adhikari *et al.,* 2012).

3.5 History and Background of Twitter (X[5])

Twitter (now referred to a X) is a real-time communication platform founded in 2006 that supports 140-character tweets to followers of the users. Messages posted on Twitter are seen and responded to instantly, and the flow of messages is constantly refreshed to get new updates. This platform is convenient for communicating shared events, like earthquakes, sports updates, festivals and a pandemic like COVID-19, where tweets can be sent as real-time updates. Twitter provides a platform through which users can follow popular leaders and events by following another user and be updated without the followed user having to follow them in turn. The follower can see the tweets, which are updates on the activities of the account being followed. When responding to tweets, there are popular components of practice, i.e., retweet (RT);'@', which filters the user address; and'#' hashtag, which highlights the topics or keywords under discussion. Another feature of Twitter is that users can change the layout of their profile, and the page has got @feedback, where all the feedback is posted. In addition, the user can view all the people who are following through a follow request, and users can view recently accessed profiles and some privacy options such as tweet privacy and tweet location.

Twitter's revenue comes from advertising, promoted accounts, promoted tweets and promoted trends. In addition, there are other sources of income like subscription-based services (Twitter Blue) which provides extra features and tools for a monthly fee (Ahmad, 2011; Chinthakayala *et al.,* 2014; Alhabash and Ma, 2017).

In 2007, the SNS platform was recorded as a company with its user base continuing to grow rapidly. The initial character limit of 140 characters for tweets forced and shaped users to become very concise and creative with how they write and relay their messages. Features like mentions, hashtags and retweets were introduced as a way of conveying meaningful messages with a limited number of

[5] As of the time of writing this thesis, Twitter is being rebranded as X by its new owner. X and Twitter will be used interchangeably throughout the thesis without loss of generality.

characters. Between 2008 to 2015, three people, namely Jack Dorsey, Evan Williams and Dick Costolo occupied the position of Twitter CEO, although by the end of 2015, the position had returned to its initial owner Jack Dorsey.

In 2010, Twitter developed a new website version with multimedia integration, which was welcomed by its users to the extent that the site had 50 million tweets per day. This growth was an unexpected advantage as the company acquired the opportunity to partner with media companies to assist with real-time coverage of events. In 2011, features like promoted tweets, a facility that enables advertisers to pay for their tweets to be broadcasted on top of results or in timelines, were introduced. In addition, Twitter Cards, which enables multimedia content to be embedded within tweets, was launched.

The subscriber base on Twitter continued to grow, such that by 2012, it had become the most popular SNS platform globally, and its users had reached 100 million. In the same year, Twitter made some noted acquisitions of social media analytics and social media dashboard companies, Bluefin Labs, RestEngine and Dasient. Twitter users surpassed 140 million by the end of 2012 because of Twitter's advantages over other SNSs, such as real-time communication and rapid information sharing with the aid of hashtags and trending topics.

Twitter acquired MoPub, a mobile advertising exchange, and Periscope, a live streaming application integrated into the Twitter platform. This happened in 2013 when Twitter lagged behind its competitors, like LinkedIn, Facebook and Google. Twitter went public and was listed on the New York Stock Exchange with the symbol TWTR, and in 2014, took over a mobile advertising company (Tap Commerce) in trying to build up its name.

Throughout its journey, Twitter has faced criticism over the way it handles the issue of misinformation and hate speech on its platform. In 2016, the mission was to crack down the abusive behaviour by introducing tools to combat hate speech and harassment. Twitter increased its character limit from 140 to 280 characters in 2017 and in 2018, formed new policies attempting to curtail fraud and deception towards its users regarding cryptocurrency advertisements. In 2019, Twitter broadcasted that it was removing the location tagging feature in their tweets, citing privacy concerns; and further announced that the company intended to ban all political advertising to avoid such advertising masquerading as information.

Twitter acquired a newsletter service, Revue and a messaging app called Quill in 2021, aiming to enhance its communication services with tools that enable advanced content layout and sorting. Quill's features are very useful to users who manage large volumes of messages that need to be maintained and organised to enable communication with all of them. Its features include sorting, filtering, ranking, streamlining and archiving messages.

In September 2022, Elon Musk acquired Twitter for $44 billion, purporting that the platform's value had been reduced to less than $44 billion. Musk changed some rules and regulations on Twitter,

removed live locations on the SNS and links to Twitter's competitor's platforms and reinstated accounts (Ayora, Horita & Kamienski, 2021; Aziz & Dakhil, 2021; Hine, 2020; Hutchinson, 2021, 2022, 2023; Jack, 2020; Pereira, 2023).

3.5.1 Twitter Features

All SNSs have unique features that inform users' decisions about whether or not to subscribe and continue using them. The section below discusses the key features that shape the Twitter SNS.

3.5.1.1 Tweets

Tweeting is the main feature of the Twitter platform and allows for quick communication in 280-character messaging. With tweets, users can express their views through texts, videos, images and links to other messages. Tweets are visible to anyone on the platform, whether or not you are a follower of a user and are immediately available to a follower in real time. Due to such real-time communication, tweets can spread easily and rapidly, making them a good tool for breaking news and updates on dire situations like earthquake damages and updates on such occurrences. Tweets use hashtags to like, retweet and reply, and enable retweets in conversations to make conversations easy to follow and organise (Ayora et al., 2021; Boehm & Hanlon, 2021; Chen, Duan & Yang, 2022; Hine, 2020).

3.5.1.2 Hashtags

Hashtags allow users to organise tweets in a specific format by following particular topics, which would, in turn, enable users to locate conversations easily. A user can create a group of conversations under a certain hashtag and then create a link that is clicked to follow the conversation. Users can categorise and organise their tweets according to a specific topic. Hashtags increase the visibility of tweets, thereby obtaining a larger audience, with most of them displaying on the trending section of the platform, allowing users to participate in trending topics (Ayora et al., 2021; Cheplygina et al., 2020; *Code of Practice on Disinformation – Report of Twitter for the Period H2*, 2022; Lee & Song, 2022).

3.5.1.3 Retweet (RT)

This is when users comment and share someone else's tweet, resulting in information being relayed more quickly across the platform, e.g., one tweet being shared by five different people will reach a larger audience than a tweet sent by only one person. Accordingly, this attracts more views, likes, followers and replies for the original tweeter. When the tweet is displayed in the retweeter's timeline, it increases its visibility and the importance of the message is emphasised. This feature is mostly used by political parties in their campaigns, for social activism, and other awareness campaigns like health awareness, potential disease outbreaks, national disasters, etc. (Lee & Song, 2022; Marin, 2021; C. Wang et al., 2020; Yan, Toriumi & Sugawara, 2021).

3.5.1.4 Direct Messages (DMs)

DMs allow users to communicate privately and directly with other users by sending messages, photos, GIFs, videos and links. These are more suitable for private engagements, customer service sessions, reconnecting with family and friends, collaboration in teams and groups and general chats. The DM facility can be accessed either on the mobile Twitter application or the website (Cheplygina et al., 2020; Curran, O'Hara & O'Brien, 2011; Hand et al., 2021).

3.5.1.5 Moments

Twitter Moments is a feature that collects and organises a collection of tweets from a trending topic, including retweets and tweets, images and videos, and present them as popular tweets or retweets. Such popular tweets would be displayed on users' timelines and regularly updated with more trending content. Moments allows users to access trending content directly rather than via the search or hashtag processes. Users, journalists and editors select the trending tweets, videos and images displayed on Moments; these can be shared with followers (Helpcenter, 2023).

3.5.1.6 Lists

This feature allows organising users' accounts by interest or category, which enables managing and monitoring various accounts with the latest news and trends that fit their area of interest. The advantage of grouping accounts is that it eases accessibility to those accounts. Accounts that have been grouped can be given a name; such a name given to lists can be private or public, giving easy and quick access to the tweets. Further, an Add to List function is available for expanding the list of grouped accounts (Cheplygina *et al.*, 2020; Howoldt *et al.*, 2023).

3.5.1.7 Trends

Trending topics contemporaneously discussed on Twitter are presented whereby trending topics, hashtags and keyword topics discussed at any given time are listed. Trends can be organised by users' location and interests. For example, a user in Zimbabwe can view the top trending topics in their country, while a user interested in politics can view the top trending political topics as the country approaches the 2023 presidential elections. Trends motivate users to follow new accounts and stay up-to-date on the latest events, trends and news. An algorithm that collates feeds from each topic generates trends from content like tweets, retweets, likes and comments (Liu, 2013; Sourek, 2013; Twitter, 2022; Zhang, Man & Ng, 2023).

3.5.1.8 Analytics

The Analytics tool enables users to monitor and track the performance of their Twitter accounts, information on their followers, their tweet impressions and engagement. Detailed information about engagement, impressions and follower growth can be made available to businesses to gain a better understanding of their customers' needs and customise their content accordingly. Users can make

informed data-driven decisions about their content, monitor their performance, and track the performance of their social media campaigns using the charts displaying audience demographics, tweet performance analytics and follower growth (Ravindra, 2018; Rodrigues *et al.*, 2021; Zote, 2022).

3.5.1.9 Twitter Ads

The Twitter Ads facility allows business and individuals to promote their products and services. A group of the target audience can contain information like demographics, interest and location, which is then used by businesses to define the audience and plan their campaigns. Three advertising facilities offered by the platform are: *Promoted Tweets*, appear in users' timelines; *Promoted Accounts*, advertised to users so that they can follow them; and *Promoted Trends*, allows ads to be included in the trending topics to gain exposure and visibility (Murillo, Merino and Núñez, 2016)

3.5.1.10 Verification

The verification process requires users to apply for a review; documents such as a national ID, passport or any other document that verifies the user are needed as supporting evidence. The conditions are that the users' account should be active with no history of violating Twitter's terms and conditions. The user's account should have "a header image, a complete profile, a profile picture, confirmed phone number and a confirmed email address" for the verification process to take place. After the verification process, the user is confirmed, and the authenticity of the account is confirmed by displaying a blue badge next to the profile name. A blue badge confirms that the account is verified and is authentic, informing the users that they are following a real person or organisation (Toraman *et al.*, 2022).

3.5.1.11 Likes

Liking content confirms a user's appreciation, acknowledgement and agreement with the content by a like (heart symbol) rather than replying or retweeting the content. Users usually like content they find interesting, informative and entertaining, thereby encouraging their followers to view the liked content. The liked tweets can be bookmarked for easy access and later reference. As a result, tweets with high numbers of likes are regarded as popular or significant (Cheplygina *et al.*, 2020).

3.5.2 Uses of Twitter

Twitter is useful for instantly broadcasting breaking news; political parties use Twitter for announcements and other updates. Some of the uses of Twitter identified by this study are discussed in the next section.

Networking

The platform facilitates connecting various people with different professions, backgrounds and trades. Twitter has a user-friendly interface and a vast user base that can be utilised by users to create networks, expand their networks, build professional associations and connect with more friends with similar

interests. By following a tweet, users from different walks of life may become connected after discovering they have similar interests, related professional qualifications, studying towards the same qualification or working in related fields, thus building a network of friends. Companies and industries that post their proceedings and current affairs, like market value and job openings, are followed by different types of people interested in investing, supplying, buying and working for the company (Singla *et al.*, 2023).

News

Users are updated with real-time news from local, national and international events by subscribing to Twitter news outlets or following journalists and other news outlets. Twitter is regarded as a source of breaking news and information for many users and non-users since most tweets are forwarded to many other platforms like WhatsApp and Facebook. It is filled with important updates, real-time news, updates and wide-ranging content that has made it popular for campaigns, news alert broadcasts and other forms of announcements. News can be shared on Twitter by anyone, from journalists and news affairs to mere users who would have witnessed a certain event. Eyewitnesses usually take videos of scenes that might attract attention and add audio to support their videos or pictures. This calls for recipients to filter and take precautions with news received from such sources because the authenticity of such news might be compromised. Twitter users customise their interests and personalise their preferences to receive instant updates on current affairs and top trending news based on their preferences. Twitter also avails sensitive information that authorities may be hesitant to share, which Twitter users circulate without deliberation (Lamsal, Harwood and Read, 2020; Mujib, Zelenkauskaite and Williams, 2021; Nekrasov, Teoh and Wu, 2022).

Marketing and Customer Service

Twitter can be used by companies, brands and individuals to promote their products or services. New and existing customers can be engaged through awareness campaigns and launching and promoting new and existing products and services. The platform is also used to announce price changes on companies' products and services. Because Twitter has no borders, a wider range of prospective customers is realised. Companies and individuals can utilise Twitter's features, like hashtags, to customise content to target specific customers. Furthermore, they can take advantage of promoted tweets, promoted accounts and promoted trends in doing their business. Individuals often use the platform to build their personal brand by showcasing their expertise, sharing their opinions and building a following. Companies use Twitter as a tool to engage with customers and potential customers by engaging in real-time conversations and responding to questions, comments and concerns, thereby building trust and loyalty (Garcia-Rivera, Matamoros-Rojas & Pezoa-Fuentes, 2022; Puspita, 2022).

Education

The Twitter platform facilitates communication, collaboration, knowledge sharing, discussions, resource sharing, and providing feedback among students and educators. As with other social networking platforms, Twitter can be considered a tool to break down communication barriers, whereby even shy students can participate in discussions. Facilitators can take advantage of advertisements and use them for notices like lecture postponements lectures or venue changes (Aziz and Dakhil, 2021; Rohr, Squires and Peters, 2022). A summarised uses of Twitter in eLearning are:

- For posting advertisements: The facilitator can use advertisements as notices, for example, the postponement of lectures or a change of venue.
- For reviewing and homework: Highlighting a topic of review or article by a hashtag for discussion purposes.
- To break down barriers: Shy students can participate and contribute to discussions.
- For better communication: Real-time communication between students is achieved.
- For creating questionnaires or voting: With the aid of twtpoll.com, questionnaires can be created and discussions on specific areas can be done.
- As a digital lounge: A discussion forum that can be used by facilitators.
- As a brainstorming tool: Sharing ideas and information for both facilitators and students at any time.
- As a calendar tool: To provide direct feedback to students after evaluating their performance from previous lessons.
- For collecting and sharing resources: An effective collaborative that facilitates data and information conveyance to students and facilitators.

3.5.3 Twitter architecture

Figure 3.4 presents the Twitter application architecture; an explanation of the architecture is presented below the figure.

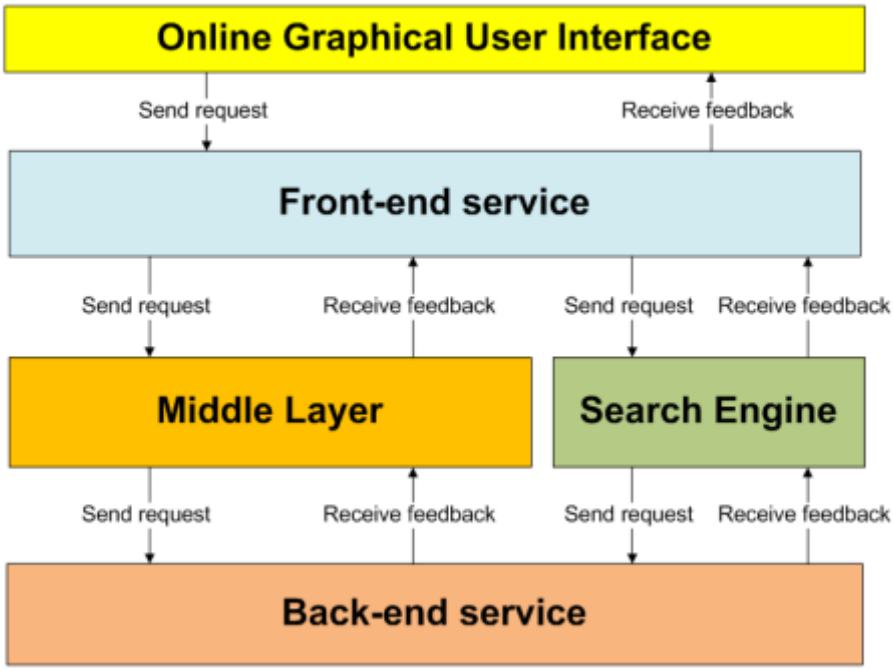


Figure 3. 1: Twitter application architecture

The Twitter architecture consists of a *back-end service layer* which is used for inserting and retrieving tweets using *Memcached*. *Memcached* is an open-source, high-performance memory used for storing all data and for fast data retrievals, with *MySQL* databases used as a backup system. The second component is the *search engine layer* implemented using Apache's *Lucene*, a high-performance and full-featured text search engine library encoded in *Java*, which uses an inverted index for indexing the warehoused tweets; therefore, word search response becomes very quick. The *middle layer* is used as a queueing system to avoid overburdening the back-end service layer. The fourth component, the *front-end service*, was built using the *Ruby on Rails* framework written in *Java* and handles all requests to the Twitter system by pre-calculating and delegating the requests for proper handling throughout the whole process in the system. The last component is the online GUIs containing all the Twitter features used in the system (Neppelenbroek *et al.*, 2011; Molnár and Vincellér, 2013).

3.6 Main Principles for the Development of Federated Social Network Sites.

The design of the federated networking site is expected to follow these three main principles (Tramp *et al.*, 2012, p. 2);

a) Linked Data: Linked data involves creating identifiers for resources on the web and linking these resources, using statements in a standard format called a Resource Description Framework (RDF). Linked data is a set of best practices for publishing and connecting structured data on the web. It is linked to other external datasets and can, in turn, be linked to form external datasets. Therefore, the principles of linked data that might be adopted are:

i. Use URIs as names for things.
ii. Use HTTP URIs so that people can look up those names.
iii. When someone looks up a URI, provide useful information using the standards (RDF, SPARQL).
iv. Include links to other URIs so that they can discover more things.

b) Service Decoupling: Making the services that are going to be provided as small and separate yet as integrated as possible so users will not find it difficult to choose between the services and applications they want. The process also helps users to have easy access to their data, and when sharing it, it will be faster to transfer.

c) Protocol and Architectural Minimalism: This helps to define the boundaries of the framework so no unnecessary data are retained. Further, it means easy interpretation of the data to enable a smooth flow of communication. In architectural minimalism, the study focuses on "reducing the complexity of an interface by transparently distributing its functionality across minimal parts, without compromising the power of an architecturally minimal design" (Obendorf, 2007; Bizer and Berlin, 2009; Adhikari *et al.*, 2012; Neish, 2015; Nikolic and Vasilski, 2017).

3.7 Summary

Chapter 3 provided an overview of four selected types of social networking sites, namely Facebook, LinkedIn, Youtube and Twitter. The study explored the history, features, uses and architectural design of each SNS, aiming to gain insight into what the sites have in common, how they are designed and the differences between them. The commonalities noted in these SNSs are comments, even though they can be expressed differently by each SNS and messaging and notifications, among others. These SNSs are used for general socialisation, business and educational purposes. This chapter, in conjunction with the previous chapter, successfully addressed SRO1 by answering SRQ 1, i.e., scrutinising SNSs, outlining their characteristics and providing an overview.

This information was used in the development of the federated networking site. The proposed model followed in the development of the proposed FSNS4eL was also discussed in Chapter 3. The next chapters discuss the benefits and and shortfalls of eLearning and different types of eLearning frameworks in Chapter 4, leading to the development process of the conceptual framework of the FSNS in Chapter 5.

Chapter 4 : eLearning Frameworks

4.1 Introduction

The previous chapter discussed the typology of social networking sites, explaining their nature as well as presenting the basis and foundation of federated social networking sites. The analysis of the existing

social networking sites revealed how they were conceived, the software and databases that constitute the systems, update and maintenance issues and the security features of the applications. At present, most of these social networking sites are not interoperable; consequently, they are competing to achieve the highest target number of users. Currently, no existing literature addresses federating social networking sites for the purposes of eLearning in developing countries, particularly in Zimbabwe.

To achieve the above-mentioned objective, Chapter 4 comprises the assessment of eLearning types, the advantages and disadvantages of the use of eLearning in educational institutions and the different types of learning tools on extant eLearning frameworks. The study then deduced the common building blocks of these frameworks used to feed the development of the conceptual framework, as described in the subsequent chapter.

In this chapter, the working sub-research objective is: *To explore existing eLearning frameworks to build a strong foundation for the proposed eLearning framework.* This is expected to be satisfied if SRQ2, *What existing eLearning frameworks are found in the literature?* is answered satisfactorily.

4.2 eLearning

In the digital age, eLearning has become mandatory, and considering the virtual era, where everything is digitalised and virtualised under the Fourth Industrial Revolution, institutions are forced to engage in an effective eLearning environment since face-to-face learning is becoming obsolete and being replaced by virtual learning. Furthermore, computers and mobile devices are becoming widely adopted and used in the educational environment. eLearning is an educational paradigm whereby teaching and learning take place in the digital world. Within this paradigm, learners receive educational facilities from their institution from the comfort of their homes or anywhere away from a physical classroom. This can be facilitated by the use of ICT tools such as computer devices, internet facilities and audio- and video-enabled devices for the delivery of educational content, thereby allowing students to interact with the facilitator (Oye, Salleh & Iahad, 2012).

eLearning is the provision of electronic educational content through computer-based media and networks. This allows for two-way communication between facilitators and students or student-to-student, with the possibility of completing the learning process at any time and place and at a speed that suits given conditions. eLearning is an approach to teaching and learning, representing all or part of the educational model applied based on the use of electronic media. In addition, eLearning requires devices as tools for improving access to training, communication and interaction and facilitating the adoption of new ways of understanding and developing learning (Sangrà, Vlachopoulos & Cabrera, 2012). Successful eLearning should achieve the following (Burns, 2011):

- Deliver multichannel instruction encompassing print-, audio-, visual- and video-based content.

- Provide multiple formats for text-based, audio and video-enabled real-time communication and collaboration with peers across the globe.
- Offer anytime, anyplace learning.

4.2.1 eLearning Tools

This subsection explores the requisite tools and technologies for the successful implementation of eLearning by learning institutions:

(i) The Internet and the World Wide Web: The internet can be used to advertise and promote eLearning programmes; notices to existing and prospective learners can be posted on the institution's website through the internet.

(ii) CD-ROM and Flash Disks: When instructors prepare learning material such as study packs and video tutorials, they can save them on support technologies such as CD-ROM and flash disks to give to students. In turn, students would use them by executing them on their computers whenever they need to study. This has the advantage that the student does not need to be connected to the internet for them to study since they can replay study material until they understand the contents and concepts (Blezu & Popa, 2008; Chuang, 2009; Lee, Abdullah & Kiu, 2016; Nkechinyere, 2011; Oye et al., 2012).

(iii) The Internal Network (Intranet): An intranet is a localised internet which is operational and active only within the internal boundary of the learning institution. When using the intranet, functioning computers and other electronic devices are connected to a common connection to communicate and share other resources. Such a connection is purely internal; students can only have active access with the learning institution's credentials. In such instances, the instructor can rely on the internal connection to share educational materials with the learners (Blezu & Popa, 2008; Chuang, 2009; Lee et al., 2016).

(iv) Video Conferencing (Video conferences): Used by facilitators to schedule virtual meetings or lectures, discussions and collaborations. This technology enables students and other participants to join meetings virtually using an invitation usually sent in the form of a link, enabling participants to join from wherever they are. Video conferencing enables participants to feel as if they are in one room with other participants and the facilitator; presentations can be viewed by everyone and visual aids are readily seen, depending on the recipient or presenter's network connection (Chuang, 2009; Gilbert, 2015).

(v) Audio Conferences: This is considered a less expensive mode of conferencing, compared to video conferencing where the technology used is a regular phone and the attendees dial a common number for the conferencing line. Other examples of audio conferencing are *Zoom*, *Google Meet* and Microsoft *Teams*, where attendees disable their cameras, which reduces the bandwidth needed for video conferencing (Chuang, 2009; Gilbert, 2015).

(vi) Interactive Video: A step-by-step explanation of specific subject matter, of which YouTube videos is an example. The student follows what is being demonstrated in the video, e.g., during a practical lecture, an interactive video allows students to follow the steps being illustrated in the video. The video is recorded by the instructor as if he is talking directly to an audience in a physical room, and thereafter, the recording becomes available (Blezu and Popa, 2008; Oye, Salleh and Iahad, 2012).

(vii) Satellite Programmes: Mostly used by volunteering departments to provide educational content to the whole country through broadcasting to compatible devices, allowing every learner with a compatible receiver to benefit by tuning in to that radio or TV station at that particular time. This can be provided in audio or video format that only allows one-way communication unless the instructor decides to open a line for the class or by using a platform like WhatsApp to allow messages to be sent to the instructor (Blezu & Popa, 2008; Chuang, 2009; Lee et al., 2016; Nkechinyere, 2011; Oye et al., 2012).

(viii) Virtual Classrooms: Similar to video conferencing. Students are already enrolled in the class, either by invitation, manual addition or joining automatically if they are registered for that particular module. It allows interactions between the instructor and the students in real time as if they are in a physical classroom (Blezu and Popa, 2008).

4.2.2 Types of eLearning

There are four types of eLearning, namely online learning, distance learning, blended learning and M-learning (Kumar Basak, Wotto & Bélanger, 2018).

4.2.2.1 Online Learning

Online learning is an educational process during which learning takes place synchronously or asynchronously through the internet. While in the synchronous model, tutors and learners interact in real time, the asynchronous approach is unidirectional, and learning material is pre-loaded by the instructor for consumption by learners at their own pace and time.

Contents disseminated during online learning include graphics, animation, text, audio and video. In this type of learning, students often receive lectures through live streaming. They can discuss any matters with the tutor and receive instant feedback when the mode of communication is synchronous (i.e., live). This approach contrasts with the asynchronous mode, in which questions are sent to the tutor after consuming the learning material and feedback is received thereafter (Aparicio, Bacao and Oliveira, 2016; Dhawan, 2020).

4.2.2.2 Distance Learning

Distance learning is a form of education that takes place remotely, often using the internet to connect students and teachers. It allows learners to access educational material and participate in classes from anywhere and at any time, provided they have an internet connection. Distance learning can take many

forms, including online courses, webinars, video lectures and interactive simulations, among others. In addition, students are given study material via physical post, email, the internet and other mediums used for online learning. The main difference between online learning and distance learning is that online learning is mostly provided to compensate for classroom learning, while with distance learning, students register to study from home or elsewhere and are not required to attend physical classes. It is mostly intended for part-time learners. Distance learning traditionally targeted full-time workers, students from remote regions or different countries who were unable to attend in-person classroom lectures. In distance learning, the institution does not have to build lecture halls for students, meaning it reduces costs and increases revenue because student numbers can be high since there is no physical limitation to attendees. The students benefit by receiving an education in parallel with their work commitments, especially people with superiors who do not encourage their subordinates to equip themselves with knowledge.

4.2.2.3 Blended Learning

Blended learning is a hybrid approach that combines face-to-face and online learning. This format allows for instruction to take place in both the physical classroom and online, with the online component serving as a seamless extension of the traditional classroom experience. In-person class time is reduced and complimented by online time, which is also a viable option for students who can only study part-time and cannot spend all their time on campus but can attend scheduled short-period blocks (Dziuban et al., 2018; Lee et al., 2016; Singh, 2005).

4.2.2.4 M-Learning

M-learning refers to the utilisation of portable devices such as mobile phones, which possess features like SMS, GPRS, MMS, email, packet switching, WAP, Bluetooth and ShareIt. Students can receive educational material, send feedback, attend virtual classes, participate in videoconferencing and share files, even through Bluetooth, provided that they are within Bluetooth transmission range. The compatibility of the devices used in M-learning makes the technology user-friendly. With just a mobile phone, individuals can attend online lectures, receive learning material, research, type assignments, submit them through the internet, make calls and communicate with others. In recent times, mobile phones have become popular among students because of the availability of useful applications such as Microsoft Office packages. This means that students can research, type assignments and submit them using their mobile phones, considering that a basic mobile phone able to execute all those tasks is much more affordable than a computer (Chuang, 2009; Burns, 2011; Lall *et al.*, 2019).

4.2.3 Benefits of eLearning

eLearning offers many benefits to its stakeholders, i.e., administrators, instructors and students. It has simplified the teaching and learning process due to the use of smart technologies, albeit with implementation challenges. eLearning enables good collaboration among students through its ease of

communication, whereby students can share ideas on different topics of discussion. In cases where students are naturally apprehensive, communicating via a computer network puts such students at ease and allows them to express their views freely. Another benefit is the absence of time limits to accessing educational resources with asynchronous systems since reading material can be uploaded and, thereafter, the student can download the material whenever they are free, which is a considerable advantage for part-time students. Asynchronous eLearning also improves students' grasp of their academic content because of the availability of the study material at any time, meaning they can read or play one topic as many times as they want or need to. The communication relationship between students and instructors also improves because the instructor is only one click away (Kuimova, Kiyanitsyna and Truntyagin, 2016; Abed, 2019; Dhawan, 2020; Mukhtar *et al.*, 2020).

4.2.4 Limitations of eLearning

A major concern within eLearning environments is the limitation of technology to support the learning process fully. The prevalence of poor network connectivity, lack of electricity in many areas, and a shortage of electronic devices are significant obstacles to the successful implementation of eLearning. Poor infrastructure, constant power outages, inadequate computer laboratories, inadequate IT support and the lack of an eLearning policy and support from university management are some of the challenges encountered in the eLearning processes. Students who attend lectures from home could be distracted since the home environment is naturally not suitable for learning purposes. This is especially prevalent in developing counties where most families do not have study rooms, let alone any free room as some families may only have a few rooms like a kitchen, dining room or bedrooms (Moakofhi *et al.*, 2017; Ali, Uppal and Gulliver, 2018; Roman and Plopeanu, 2021; Zarei and Mohammadi, 2021).

4.3 eLearning Frameworks

An eLearning framework is a complete guide with the steps required to build, manage and evaluate the eLearning solutions in the educational sector. It is a set of guidelines that provide a logical approach to creating educational content and delivering online tutorials. eLearning frameworks facilitate education by ensuring that all the necessities for online learning are available, such as the technology, supporting services, staff and policies.

In the next subsections, the study explores a range of existing eLearning frameworks in the literature and summarises the contributions of each framework. This guided the study in developing a framework containing the essential building blocks for a strong and useable framework.

4.3.1 Khan's eLearning framework

eLearning is an innovative way of providing educational services to stakeholders working from the comfort of their offices, homes or any place that is conducive to conducting, facilitating and attending

online education and its services. Khan divided the framework into eight categories, namely institutional, pedagogical, technological, interface design, evaluation, management, resource support and ethical elements, as shown in Figure 4.1. The framework can be implemented in eLearning systems to create an effective environment for learners and instructors to abandon the closed system learning design mentality.

The framework's elements can be arranged into three main domains that need to collaborate for eLearning to be successful:

(i) Educational Sector: Comprises pedagogical, ethical and evaluation that work together with the instructor and learners, how they exchange instructions, and where, when and how their work is evaluated.

(ii) Technological Sector: Entails two elements, technology and interface design, as the infrastructure for students to receive instructions, the medium of communication, the hardware and software and their design. A characteristic of the interface (among others) is that it should be user-friendly, which means the user should be able to navigate and obtain the necessary content with minimum difficulty, with some of the functionalities explained step by step to enable usability.

(iii) Managerial Sector: Encompasses the institutional, resource support and management elements mostly utilised by the management and supporting staff. They should support instructors and learners with the requisite resources, in the right environment and provide a workable roadmap for both learners and instructors.

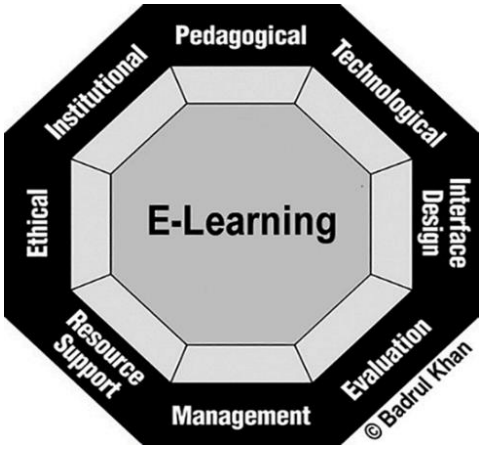


Figure 4.1: Khan's framework adapted from Khan (2010, p.46)

4.3.2 Blended Multimedia-based eLearning Applications Framework

This is a modification of Khan's eLearning framework, with culture added as an additional element, which considers language, social, religious, economic and political background as such elements have an impact on the way eLearning is embraced and utilised effectively. This framework is a combination of face-to-face and eLearning, employing synchronous and asynchronous media to obtain the maximum benefit from the system. Figure 4.2 below depicts the framework, of which a full description is provided by Zanamwe (2010, p. 73).

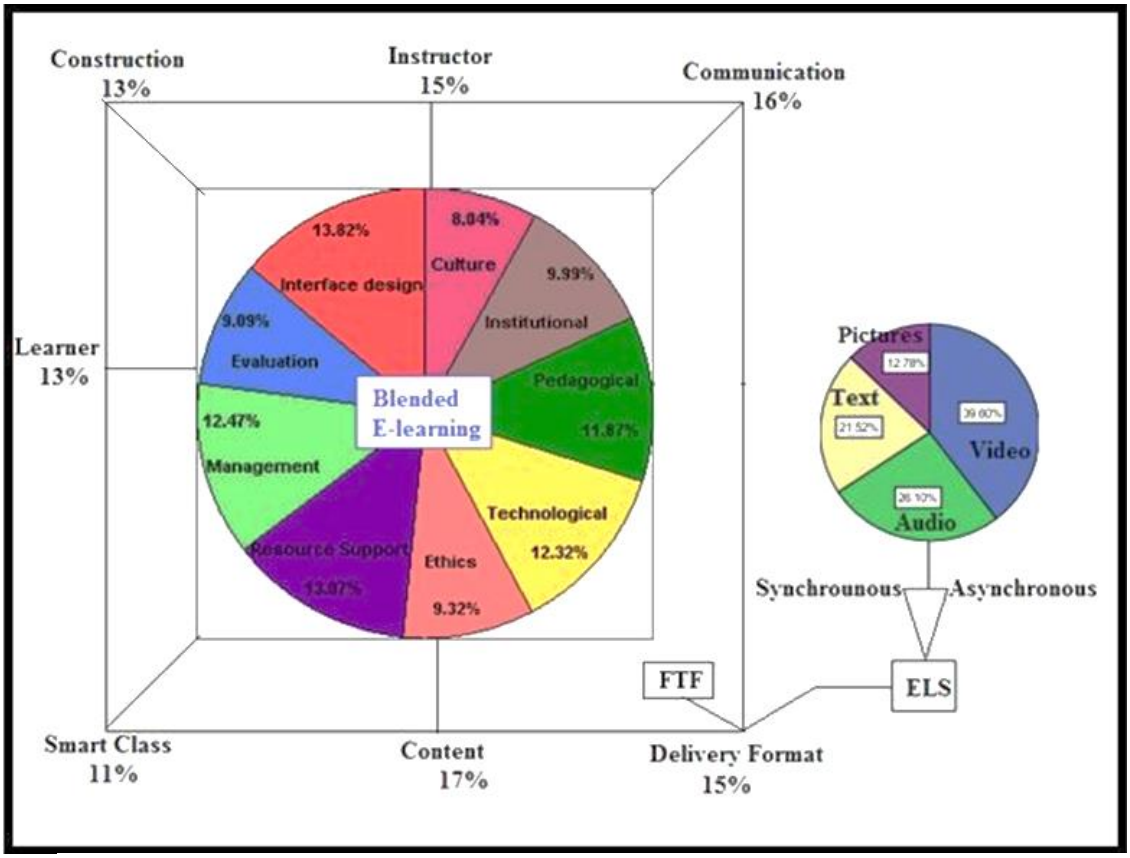


Figure 4.2: Blended multimedia based eLearning applications framework

4.3.3 eLearning Systems' Theoretical Framework

The eLearning system (figure 4.3) borrows some and the major components of information systems to aid in synchronous and asynchronous teaching and learning in institutions. People who teach and learn in good spirits are a requirement for effective teaching and learning. Management must support the learning process, and the board and shareholders should support the smooth running of the learning process by implementing supporting policies. These could include controlling load-shedding during electrical shortages and liaising with network services to ensure reliable internet services. eLearning technologies provide a medium for data transmission; the availability of the technology determines the quality of the eLearning systems, which enables different modes of learning. Students can benefit from uploaded content, saved documents, pre-recorded video and audio, and educational broadcasts via radio and television, or they can participate in virtual lectures, collaborations and group discussions—asynchronous and synchronous learning, respectively. eLearning services are activities that should be

conducted correctly after obtaining support from people and technology. These can be collaborating, online lessons, online tests and assessments, among others.

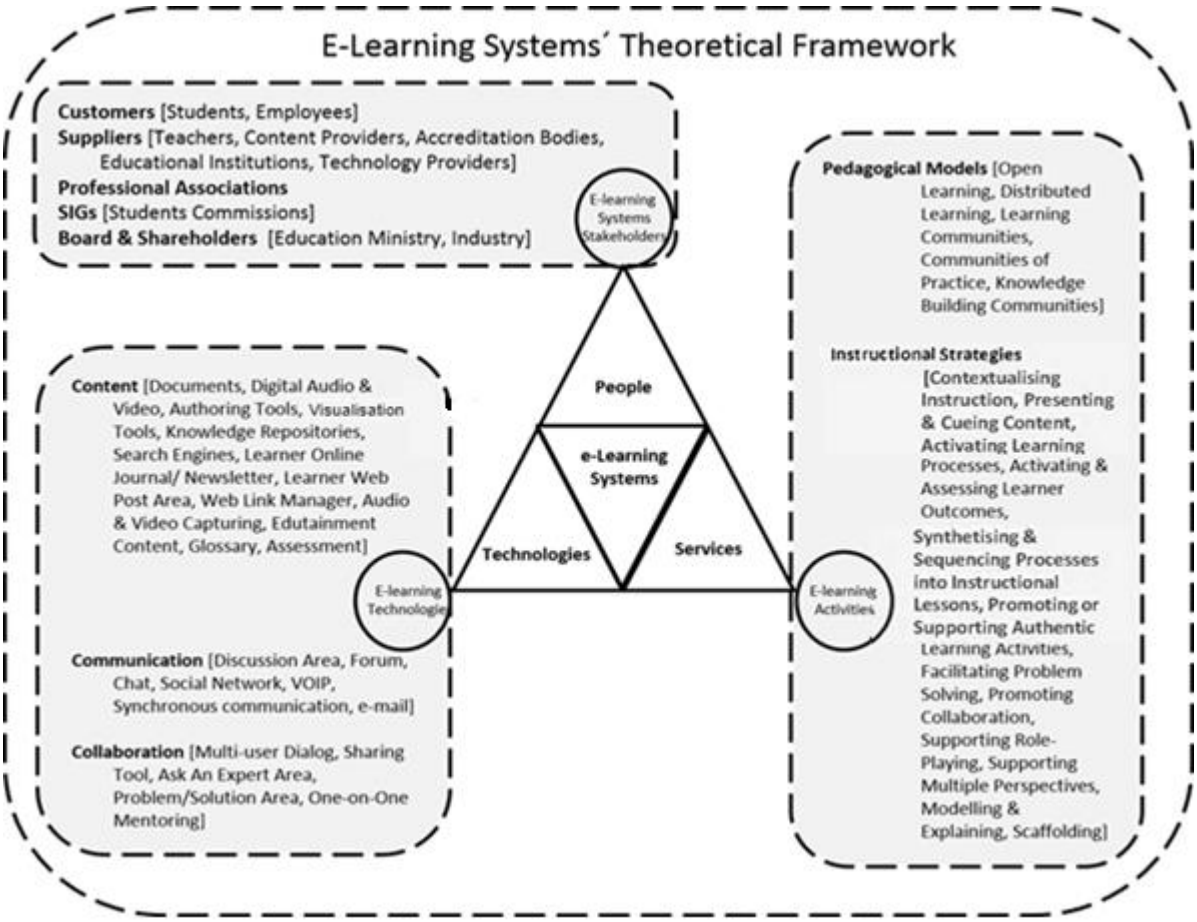


Figure 4.3: Holistic eLearning systems theoretical framework (Aparicio et al., 2016, p.302)

4.3.4 eLearning Integration Framework

This framework (figure 4.4) has three stages that can be likened to the stages of the waterfall model: planning, analysis, designing and implementation. The framework's first stage, *Before* (planning and analysis) is a process of identifying the methods to be used and analysed to ascertain their feasibility considering the local infrastructure. Further, listing and comparing alternatives is undertaken during this stage. The best approach is adopted, bearing the background checks of the system users in mind. In the *During* (implementation) stage, the proposed infrastructure, methods and learning environment are compiled for the learning process to be executed with the aid of tools such as videos, audio, chatrooms and discussion forums. In the *After* (implementation) stage, the assembled systems are assessed, and their performance is evaluated. This evaluation also includes users of the systems and how they performed when using the systems, identifying any loopholes or challenges, and recommendations to be considered during the process of improving the system.

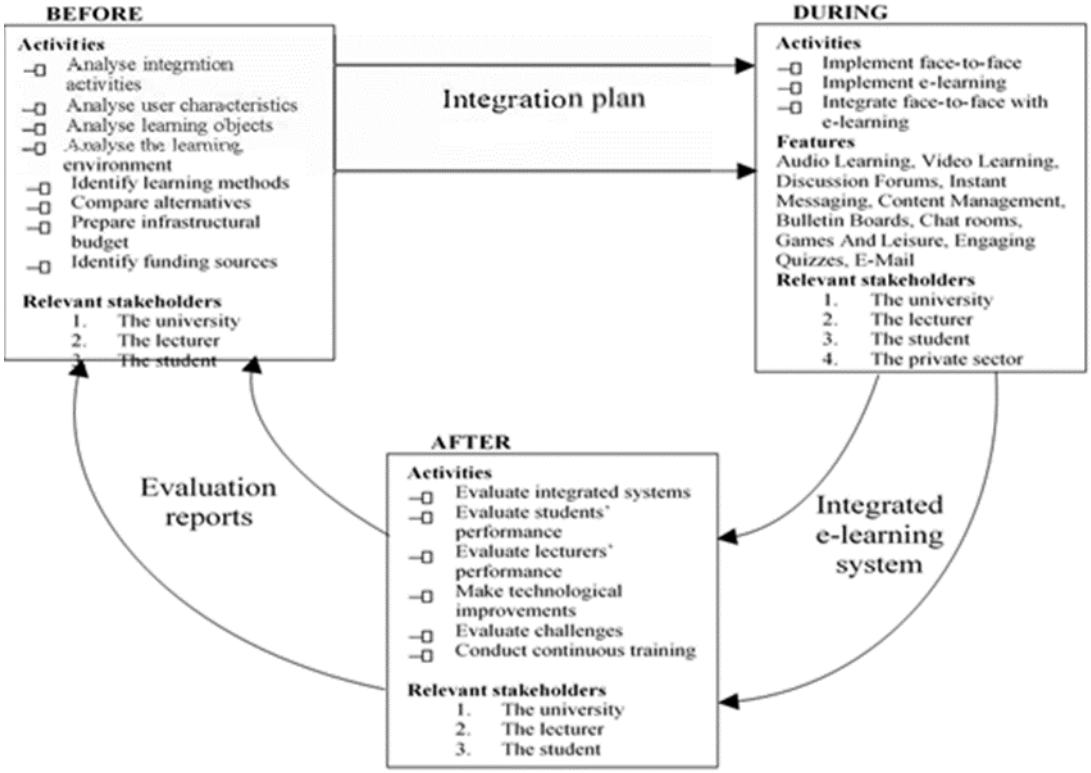


Figure 4.4: eLearning Integration framework (Kituyi & Tusubira, 2013, p.30)

4.3.5 A Conceptual Framework for Social Network to Support Collaborative Learning (SSCL)

According to Yampinija, Mayuree and Chuathong (2012), the learning process depends on the learner: They must have the right attitude backed up by the computer systems for them to collaborate. The main construct feeding into the system is knowledge construction, subdivided into cognitive constructivism, social constructivism and metacognition. Cognitive constructivism allows the student to develop their understanding, meaning and significance, either when collaborating with other students and their instructors or by themselves, without collaborating with other students or tutors. Instructors should devise situations and learning activities that encourage students to understand the content independently rather than being indulged and accommodated by lecturers (spoon-fed) (Powell and Kalina, 2009). Social constructivism refers to learning as continuous development that requires constructing knowledge and reflecting thoughts in social settings and students developing understanding, meaning and significance when collaborating with other students and instructors (Amineh and Asl, 2015; Keengwe, 2017). Social constructivism encourages learners to discover concepts, facts and principles for themselves through deductive reasoning and instinctive thinking. Metacognition delves more into students monitoring their thinking, although it is related to cognitive constructivism in the sense that the student has to take charge of their learning to understand better. At this point, students should demonstrate self-confidence in their thinking, cultivating an inner voice to support whether their thinking is correct or incorrect, knowing their weaknesses and when to seek help (Pang, 2010).

The social network, as another construct, is a communication tool that feeds into the SSCL and enables student-to-student collaboration, teacher-to-student communication and interaction by chatting, sharing content and conducting group discussions. The concerned context construct is when the instructor

motivates and guides students to share their learning experiences on the social network for them to apply their knowledge in embracing and understanding real-world contexts to develop real-life skills that enable them to use related workplace problem-solving processes to connect learning experiences with real working life. Figure 4.5 below illustrates how Social network to support collaborative learning is fed by three constructs discussed above.

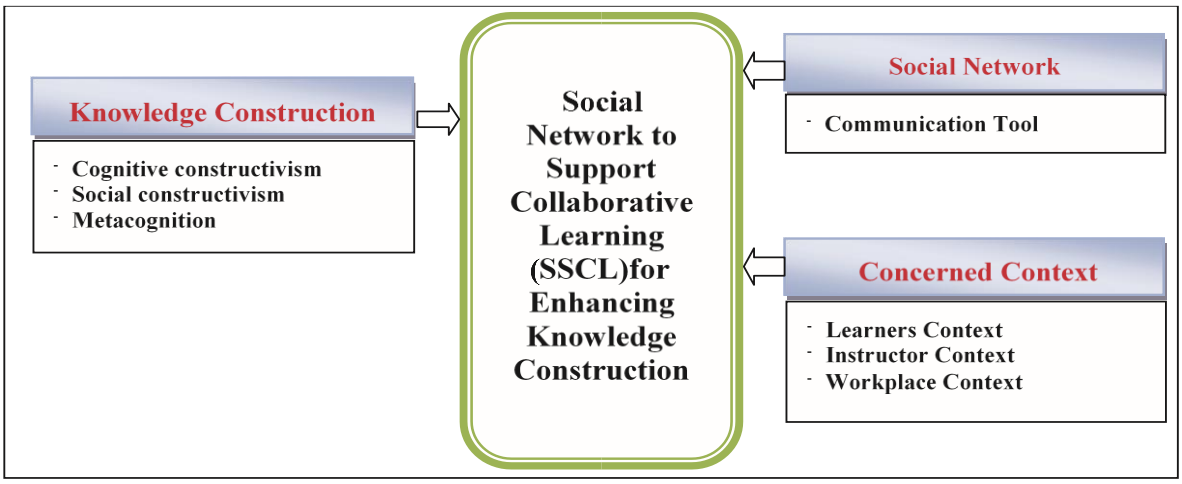


Figure 4.5: Social network to support collaborative learning (SSCL) (Yampinija et al., 2012, p.37)

4.3.6 The Framework for Using Social Media in eLearning

Figure 4.6 below depicts the framework consisting of three stages.

In the first stage, students are expected to engage in idea generation through the use of wikis and blogs. They should be guided in brainstorming content related to their disciplines to be used when collaborating with other students.

The second stage is when the student should make sense of the content available to prevent the process of idea organisation from becoming a problem. This stage also includes the problem-solving process.

Activities in the third stage entail students building knowledge and life experiences through collaboration, group discussions and other forms of learning. During this process, the student should be comprehensively guided and supported and provided with a safe environment where social media tools become functional in providing the student with communities of practice (CoP) and communities of inquiries (CoI) from the comfort of their homes (Mnkandla and Minnaar, 2017).

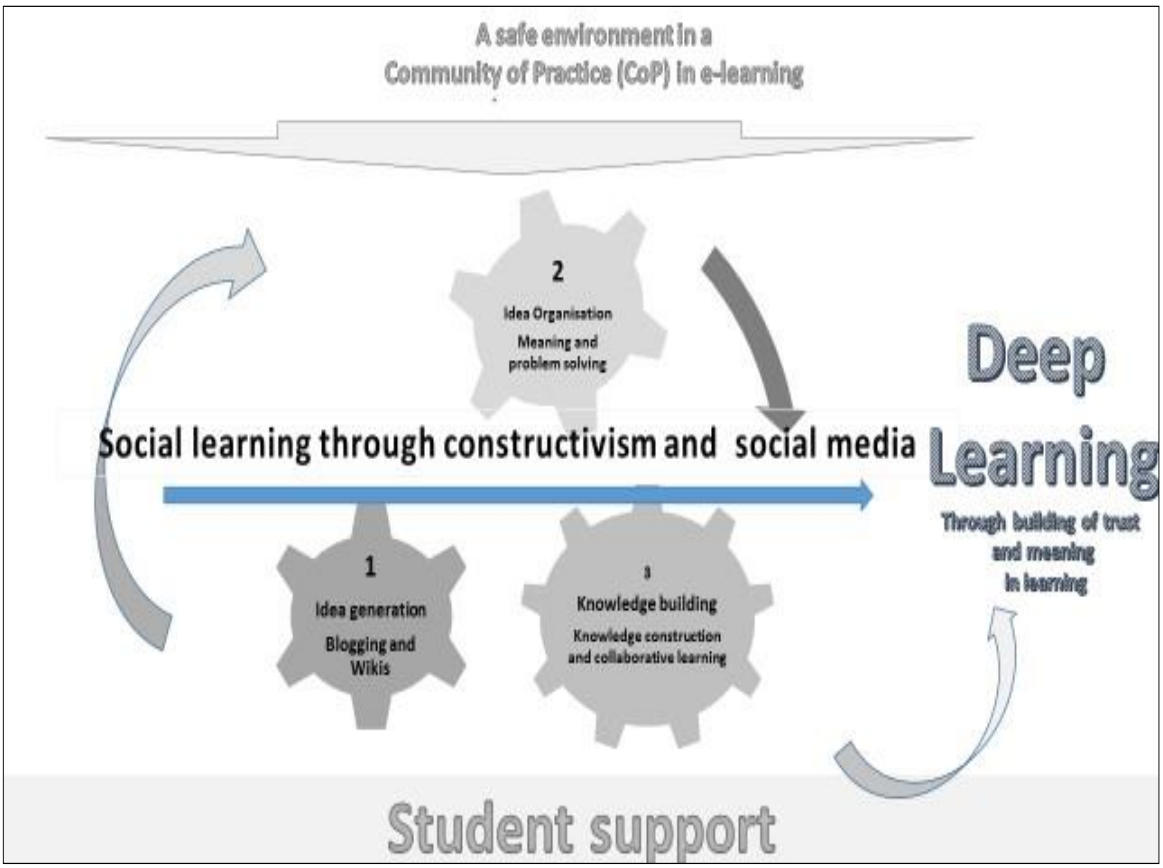


Figure 4.6: Using social media in eLearning (Mnkandla &Minnaar, 2017, p. 244)

4.3.7 Hybrid Social Networking Platform

A hybrid social networking platform is a merger of two different types of frameworks, as illustrated in Figure 4.7. It is a hybrid framework combining mobile and web applications that run a web application in the native application. As such, the hybrid framework uses a native framework, which is a program compiled to operate on the device, although it has the capability of loading data from external websites using *hypertext transfers protocol* (*HTTP*). A web framework has mobile websites that function well on a mobile device and can be accessed on a mobile browser. The mobile framework has the advantage that it can enable the integration of general semantic information, for instance, location, activity and interests. In addition, platforms like LinkedIn, Facebook and Twitter provide intelligent and user-friendly communication tools for individuals and groups (Alasmri, Onn and Hin, 2019).

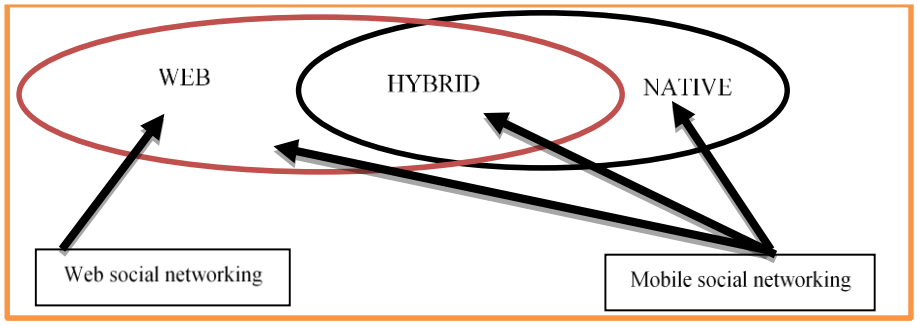


Figure 4.7: Platforms of social network (Alasmri et al., 2019, p.2)

4.3.8 Collaborative Social Networking Framework for eLearning

Collaborative eLearning emphasises group work, peer-to-peer learning and knowledge sharing, often through the use of technology such as online discussion forums, video conferencing and collaborative document editing tools. The student is encouraged to take charge of their learning through the constructivist approach, by which classmates and instructors are available to help in the problem-solving process. Figure 4.8 explains that the social networking tools will support students by providing access to blogs, discussion forums, chat rooms, file sharing, video conferencing, electronic portfolios and wikis (Mammadova, Aghayev & Zeynalova, 2020).

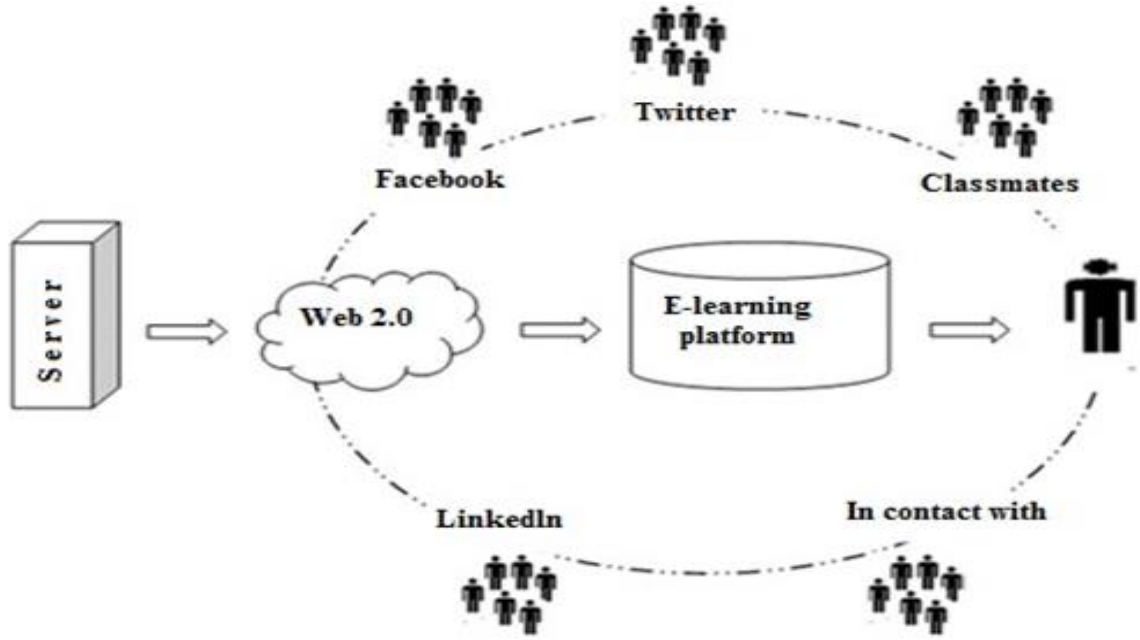


Figure 4.8: Collaborative eLearning environment with online social networks (Gulang & Zeynalova, 2020, p.32)

4.3.9 Personalised and Interactive Web-based Framework

A personalised and interactive web-based framework is an eLearning system that employs advanced algorithms and data analysis techniques to mould content and services to suit the specific needs and preferences of the individual user. Different environments are integrated to create an interactive learning environment, as depicted in Figure 4.9, in which learner-learner and instructor-learner interactions are enhanced. The shortcomings of the *Moodle* LMS include: extra work with little

connection to a course, the interface not being user-friendly, and the platform being technologically oriented rather than meeting students' specific needs. Hence the need for additional functionalities. Collaborative work or interactions currently almost nonexistent, are expected to be solved by the interactive web-based framework. The framework provides a collaborative platform that allows personal learning and socialising for students, as well as providing an environment where their individual needs and preferences are met (Wawire, Okeyo & Kimwele, 2018).

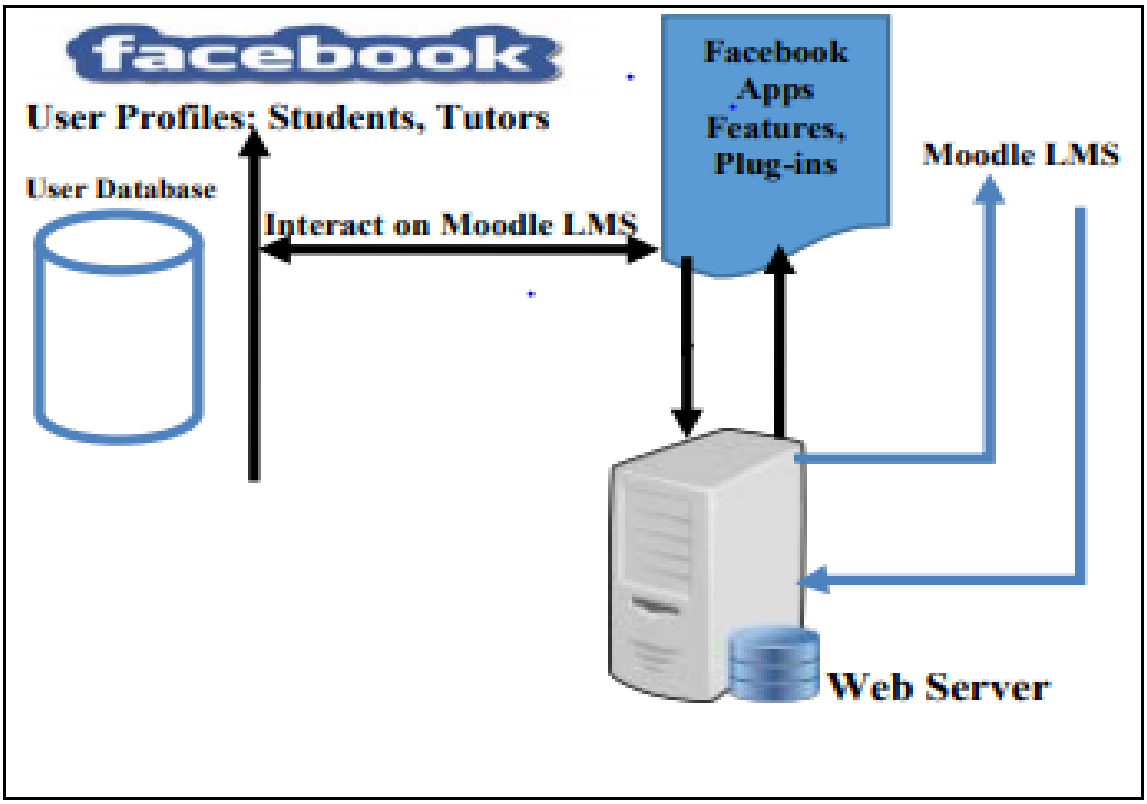


Figure 4.9: Personalised and interactive web-based framework (Wawire et al., 2018)

4.4 Common Building Blocks in eLearning Frameworks

Given that different scholars designed the eLearning frameworks outlined above, they vary depending on the framework's objectives, scope and design. However, all these frameworks have three deduced building blocks described in Section 4.4.1 below. The frameworks recognise the significance of technology, learning services and human resources as the three main components of eLearning. After discussing each building block, the thesis examines each framework and illustrates how these building blocks were implemented.

4.4.1 Building Blocks of eLearning Frameworks

The building blocks are the essential components that comprise the eLearning framework. These building blocks inform the development, delivery and effectiveness of eLearning programs guided by the developed frameworks**.**

- **Technology**: The mode used by learners, instructors and supporting staff to create, present and access educational content, as well as interact remotely. Technology includes but is not limited

to hardware such as computers, tablets, smartphones, interactive boards and software like *LMS*, Zoom, softcopy material and other computerised and digitalised tools that facilitate content creation and delivery.

- **eLearning services**: eLearning services refer to the provision of educational content and the facilitation of learners and educators in getting the required education through educational content and available resources. These include online courses, multimedia materials such as videos and podcasts, interactive discussions, educational virtual games, online assessments and quizzes, and other digital resources that support learning objectives. eLearning services are provided by individual or educational institutions, tailored according to the specific needs of learners in a specific environment or with specific needs.
- **Human resources**: The individuals involved in building, delivering, supporting and benefiting from eLearning services. These may include instructors, content creators, students, technical support staff, administrators and other professionals who collaborate to ensure learners have access to high-quality educational content and services.

4.4.2 Application of Building Blocks to the eLearning Frameworks Discussed Above.

This section explains the application of the three blocks according to each eLearning framework below:

1. **Khan's eLearning framework**: Khan discussed the three main components of eLearning, namely content, delivery and feedback. The educational sector (*eLearning Services*) works closely with the instructor and the learners to understand how they exchange instructions and where, when and how their work is evaluated. The technological Sector (*Technology*) concentrates on technology and interface design as the infrastructure in which students receive instructions and how their instructors create and post instructions to students, the medium of communication, the hardware and software and how they are designed. Feedback (*Human Resources*) refers to management and supporting staff, how they should support the instructors and learners with the right resources to work with in the right environment and provide a workable roadmap for both students and instructors.
2. **Blended Multimedia-based eLearning Applications Framework:** The eLearning framework stresses the importance of multimedia content in eLearning. Three main components of eLearning are discussed in this section. Content (*eLearning Services*) is the educational multimedia material used in eLearning, such as videos, animations and simulations. Delivery (*Technology*) is a combination of face-to-face and eLearning systems employing synchronous and asynchronous media. Interaction (*Human Resources*) refers to the platform in which learners engage with the content, such as assignments, quizzes, discussions or collaborative projects, while instructors assess and manage students.
3. **Holistic eLearning Systems Theoretical Framework**: This framework emphasises the holism of a system that encompasses all aspects of the learning experience. The holistic eLearning

systems theoretical framework consists of Services (*eLearning Services*) which refer to the activities correctly executed after obtaining support from people and technology. These can be collaborating, online lessons, and online tests and assessments, among other services. Technologies (*Technology*) refer to the ICT tools used to support the delivery of content and learning activities, such as LMSs, forum chats, VOIP, interactive whiteboards, 'ask an expert' areas and virtual reality. People (*Human Factors)* refers to persons who participate in students' learning processes. These are the Ministry of Education, industry, instructors, students and support staff.

4. **eLearning Integration Framework**: The framework emphasises the importance of integrating eLearning into classroom educational configurations that are moving from the traditional to an eLearning-enabled configuration. This framework consists of three stages supporting eLearning. **Before** (planning and analysis): a process of identifying the methods *(Technology*) used and analysed to ascertain their feasibility considering the available infrastructure. **During** (implementation): When the proposed infrastructure, methods and learning environment are assembled to execute the learning process (*eLearning Services*) with the aid of tools such as videos, audio, chatrooms and discussion forums. **After** (implementation): The systems in place are assessed and the performance is assessed by *Human* R*esources*.
5. **Social network to support collaborative learning (SSCL**): The focus of this framework is the importance of integrating social networks in collaborative learning. The framework discusses the three main constructs of eLearning: social networks, concerned context and knowledge construction. Social networks (*Technology*) aid student-to-student collaboration and teacher-to-student communication, where the interaction is chatting, sharing content and conducting group discussions. Concerned Context construct *(Human Resources*) is the instructor motivating and guiding students to share their learning experience on the social network. Knowledge Construction (*eLearning Services*) describes how students learn, divided into cognitive constructivism, social constructivism and metacognition.
6. **Using social media in eLearning**: Focuses specifically on the use of social media in eLearning, unlike the social network, to support collaborative learning. This type of eLearning framework has three components: social media platforms, learning resources and instructional strategies. Social media platforms (*Technology*) provide the student with communities of practice (CoP) and communities of inquiries (CoI) from the comfort of their homes as a way for students to connect, share resources and collaborate. Learning resources (*eLearning* S*ervices*) provide the requisite content and material to support idea generation, idea organisation and knowledge building. Instructional (*Human Resources*) strategies are the methods used by tutors to support learners and facilitate learning through? social media and constructivism**.**
7. **Platforms of the social network**: When social network platforms are used to create an interactive, engaging, and collaborative learning environment. Various social networking tools,

such as forums, groups, comments and other collaborative technologies are integrated to facilitate social interaction, knowledge sharing, and collaboration. The platforms of the social network eLearning framework comprise *Technology*: A hybrid combination of a mobile and web application compiled to operate on the device, although it has the capability to load data from external websites using the *hypertext transfers protocol* (HTTP). *eLearning services* encourage the development of students' critical thinking and problem-solving skills by providing an environment oriented towards problem-solving learning and student-centred learning, facilitating social interaction, knowledge sharing and collaboration. *Human Resources*: The instructor or facilitator provides feedback, guidance and support in an online social network learning environment.

8. **The collaborative eLearning environment with online social networks framework** This is a platform where students can interact, engage and collaborate in an online space where social networking tools enhance and support the learning process. In this framework, we identified social interaction, knowledge construction and knowledge sharing as the building blocks of the framework. Social interaction (*Technology*) creates a collaborative learning community. Knowledge construction (*eLearning Services*) encourages critical thinking and facilitates the development of students' problem-solving skills through learning activities that stimulate inquiry, analysis and reflection of the learnt content. Knowledge sharing (*Human Resources*) facilitates the transfer of content, knowledge, materials and skills among students to enhance their understanding of the course material.
9. **Personalised and interactive web-based framework**: The importance of personalisation and interactivity in eLearning is the main aim of this eLearning framework. The three main components of eLearning personalised learning environments, interactive learning resources and instructional strategies. Personalised learning environments (*Technology*) provide students with a customised learning experience on Facebook and *Moodle* (LMS) based on their individual needs and preferences, while interactive learning resources *(eLearning Services)* provide collaborative platforms that allow personal learning as well as socialising between students. *Human Resources* provide an environment where students' individual needs and preferences are met.

4.5 Summary

This chapter explored and deliberated on eLearning, eLearning tools, types of eLearning, the benefits and limitations of eLearning and different types of eLearning frameworks as the background to the development of the FSNS4eL. The types of eLearning discussed are online learning, distance learning, blended learning and M-learning, demonstrating how they are applied in an educational environment, explaining which types/groups of students are suitable for each, and briefly discussing their advantages and disadvantages.

Chapter 4 discussed types of eLearning frameworks and presented nine different types of frameworks with a common centre of attraction. The study deduced the three common building blocks that are applied in some way in all nine eLearning frameworks. The building blocks are *Technology*, which is the mode used by learners and instructors to distribute and receive educational content and also interact with instructors and learners remotely; *eLearning services*, the educational resources provided by tutors to learners or from learners to learners and *Human resources*, the tutors, IT specialists, administrators and students involved in eLearning.

The chapter concludes by showing the application of each building block in the eLearning framework discussed, thereby laying the foundation for the development of the FSNS4eL, where these building blocks were also applied. These were fused with the development theories that guided the framework development. Therefore, SRQ 2 was answered and successfully met. The next chapter describes the development of the FSNS4eL enhanced by the development process (DSM), the development theory and the development tools, such as flow charts, architectures and use cases.

Chapter 5 : A Conceptual Framework for Federated Social Networking Sites for eLearning

5.1 Introduction

The previous chapter discussed the different types of learning tools on extant eLearning frameworks and the advantages and disadvantages of eLearning in educational institutions. From the frameworks discussed, the study deduced three common building blocks considered in this chapter. The output of the previous chapter contributed to the achievement of SRO3: *To develop the conceptual federated social networking site for eLearning (FSNS4eL).*

This research proposes to produce a federated framework for social networks as a tool for eLearning purposes, drawing and analysing the features of the federated social networking site based on current social networking sites and the existing empirical data. The research intends to introduce a sound solution to the eLearning sector. The study ensures that the framework is reviewed and further endorsed by experts from the information systems field. The main thrust of developing the framework is to guide and enable students to take advantage of the contemporary ICT-based learning environment that is user-friendly and innovative yet does not defeat learning objectives.

This chapter mainly describes the manual construction of the conceptual framework, which served as a guideline to the study's empirical data-gathering processes and assisted in the development of the federated social networking sites framework, which can be used as a respite to most of the negative impact of social networking sites in the academic environment. By so doing, this chapter intends to answer the Sub-Research Question 3:

How to use technologies such as models, use cases, flowcharts and architectures to develop a framework with the guidance of the existing eLearning frameworks and framework development theories?

This section examines the framework development process and model of building theories, presents the proposed architecture to be followed and the tools to aid the design of the framework as a way of applying the requirements of the selected theory building process. Different configurations of federated networks were presented before the adopted FSNS4eL was proposed.

5.2 The Framework Development Process

The framework development followed the principles of design science research methodology, which emphasises the importance of the build and evaluate stages of the process. In addition to the primary

activities, other important components contributed to the framework development process, namely the extant literature, relevant theories and utilising various methods, models and requirements. The framework development was guided by the principles of design research methodology (DRM).

Most of the recommended guides from DRM were utilised to ensure a rigorous and systematic approach to framework development. Figure 5.1 illustrates the stages of DRM, which is an essential guiding process required when building a conceptual framework. The building process requires an awareness of existing frameworks and theories to gain knowledge on how to design a framework suitable for the environment; in this case, the framework should be suitable for the academic world. The diagram below illustrates the factors that form the knowledge base, which serves as a guide during the development process. These factors are divided into two main categories, i.e., the foundations and the methodologies that help identify the main components to include in the framework formulation.

The development process entails the developer identifying the problems and challenges the framework should address as well as the environment in which it would operate. This ensures that the designed framework meets the specific needs and requirements of the intended users and the context for which it was designed. Thus, the FSNS4eL framework developed using design science methodology (DSM) should be relevant to its environment and designed to solve its problem domain, including people, organisations and technology. The FSNS4eL framework was designed mindful of the needs and requirement specifications of these stakeholders to ensure its effectiveness and usefulness in addressing the problems or challenges it aimed to solve. Furthermore, the framework had to be able to integrate and align with existing organisational processes and technologies while also being sufficiently scalable to adapt or easily modify to accommodate future changes and advancements. In the previous chapter, existing eLearning frameworks were examined in the literature, revealing that three key components (problem areas) should be considered: Technology, Human Resources and eLearning Services. Accordingly, this is the environment that the developed framework strived to achieve. In this chapter, the focus is on examining the theory, models, constructs and instantiations that serve as the knowledge base. Additionally, Chapters 6, 7 and 8 discuss the methodology, data analysis and validation criteria of the FSNS4eL framework (Brady, Tzortzopoulos and Rooke, 2018; Ebneyamini, 2022).

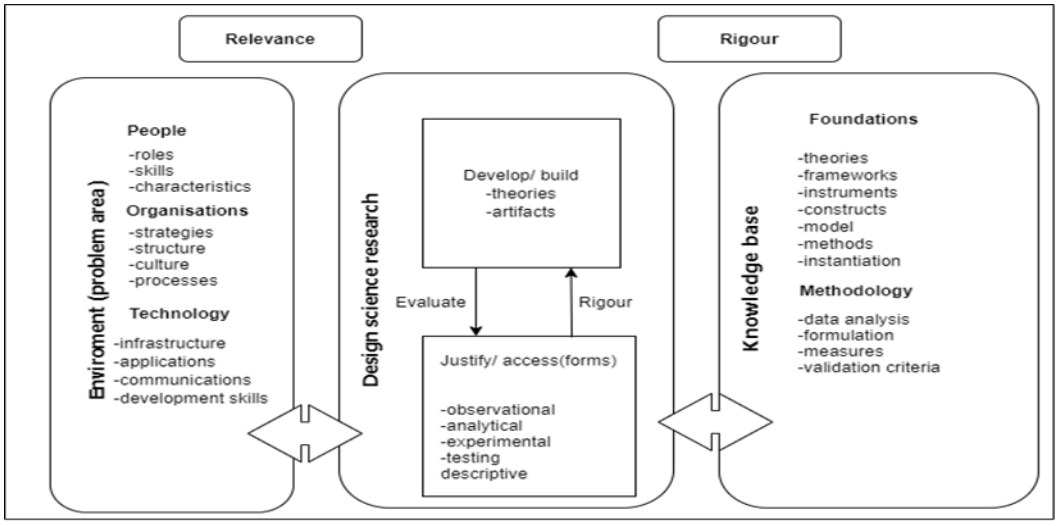


Figure 5.1: Design Science Methodology (source: Ebneyamini, 2022)

5.3 Conceptual Framework Formulation

At this stage of DSM, we develop an artefact aided by the relevant theory selected in the literature. Various extant theories underpin the study of every research; as such, this study identified a theory to guide the development of the framework. Although a theory might not provide a roadmap or guideline to developing the final framework, it is expected to advise on the components to include. Once the components had been identified, the study aligned them with the framework development process (DSM) used as a blueprint for the framework's development. A conceptual framework may incorporate components borrowed from elsewhere, but the structure and overall coherence must be built anew and may not have been in existence before (Maxwell, 2012).

The previous chapter discussed various frameworks ranging from general eLearning frameworks to social networking frameworks, which provided the theoretical orientation of the conceptual framework development at hand. Henceforth, the study presents the systematic and scientific development of the FSNS4eL guided by Dubin's theory-building process which works hand in hand with the DSR part in the DSM. The DSR section stresses the fact that we build the artefact and then verify, as it is interested in providing frameworks and guidelines for evaluation in computer-based research projects, where real problems are conceptualised, and appropriate models for their solutions are constructed, implemented and validated/reviewed using appropriate principles (Hevner and Chatterjee, 2010). We chose the Dubin's theory building process to guide this study, after considering that the development of the framework does not have any preliminary work related to the use of FSNSs in eLearning to guide the development. The Dubin's theory guides the framework development by suggesting a structured and systematically approach of theory building. The Dubin approach suggest the importance of identifying the units of the framework, the constructs and how they should be linked, thus the ideas of the researcher are moulded into logical representation.

Dubin's theory-building process emphasises that after completing Dubin's eight-stage process, as indicated in the next section, the resulting framework must have the requisite rigour and relevance,

which are the features the guiding DSM seeks to achieve by the end of the development process. The development process has two main stages, subdivided into four stages, respectively. The first four stages investigate the theory development, and upon successful completion of the first part (the theoretical section of the cycle), an informed, conceptual framework is complete. The last four stages (the research operation section) produce an "empirically verified and trustworthy" artefact (Lynham, 2002, p. 243). This outcome is only achieved when a study "consistently and conscientiously move through each of the two parts of the cycle" (Lynham, 2002, p. 244), that is the development (build) and the verification (evaluate) sections of the process. Figure 5.2 below displays Dubin's eight-phase development process.

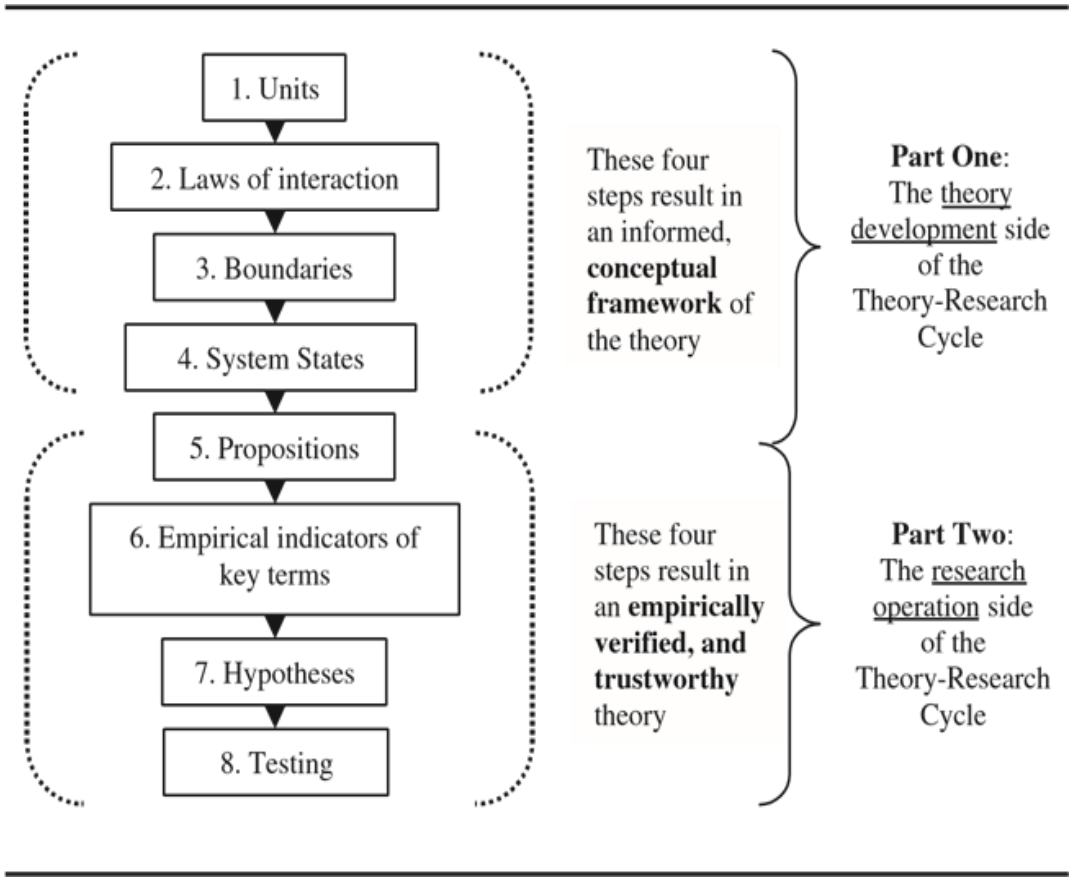


Figure 5.2: Dubin's theory-building method as an eight-step theory-research cycle (Lynham, 2002, p. 243).

In the following subsections, the study explores the relevant steps pertaining to each theory in detail to gain insight into how each step or phase is executed. This formed the basis for the development of the components constituting the conceptual framework.

As depicted in Figure 5.2, the Dubin method for developing a framework (the theory development part discussed in this chapter) consists of four major steps briefly described in the next section.

5.3.1: Unit identification

The units of a framework are the basic ideas identified for use in the development of the framework. The units depict the concepts we must understand for them to be incorporated into the framework development. The selection of the units is informed by the literature and our experience and serves as the components necessary for the development of the framework. The components/building blocks are deduced from the literature and our experience to answer the question "what are the units of the theory?" (Lynham, 2002, p. 247). The main priority of the unit identification stage is to identify and select the crucial concepts and ideas for the framework and use existing knowledge and personal experience to build a solid foundation for the FSNS4eL framework.

Figure 5.3 below describes all the requirements and processes involved in identifying the units for framework development.

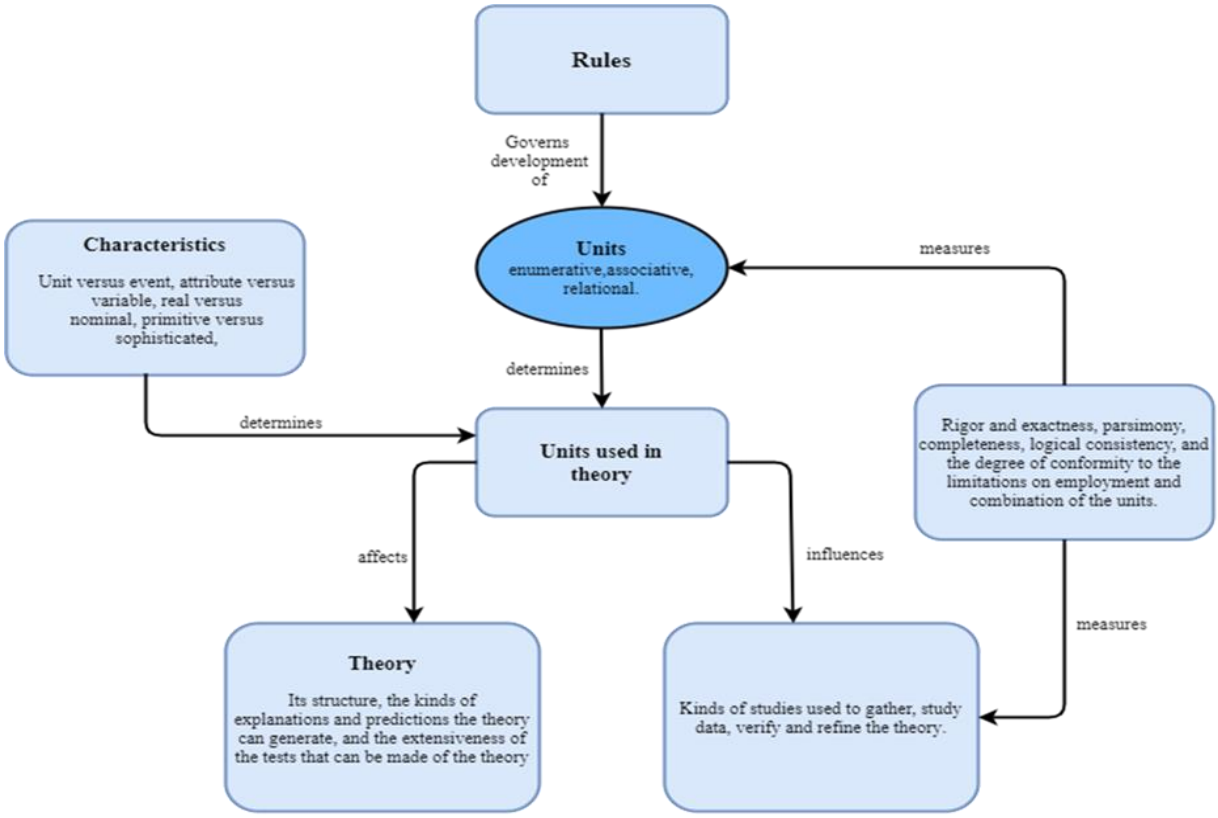


Figure 5.3: Units of the theory

5.3.1.1 High-level Architecture of the Federation of Social Networking Sites.

The high-level architecture of the framework to be developed specifies the units needed for the framework to be developed into a final framework. The main units involved are the users, the applications, the orchestration and the source social networking sites. These units are further

deconstructed, as shown in Figure 5.4 below; the units are logically arranged according to their purpose in the framework. Figure 5.4 depicts the high-level architecture of the federation of social networking sites, which is further articulated in the subsequent Table 5.1.

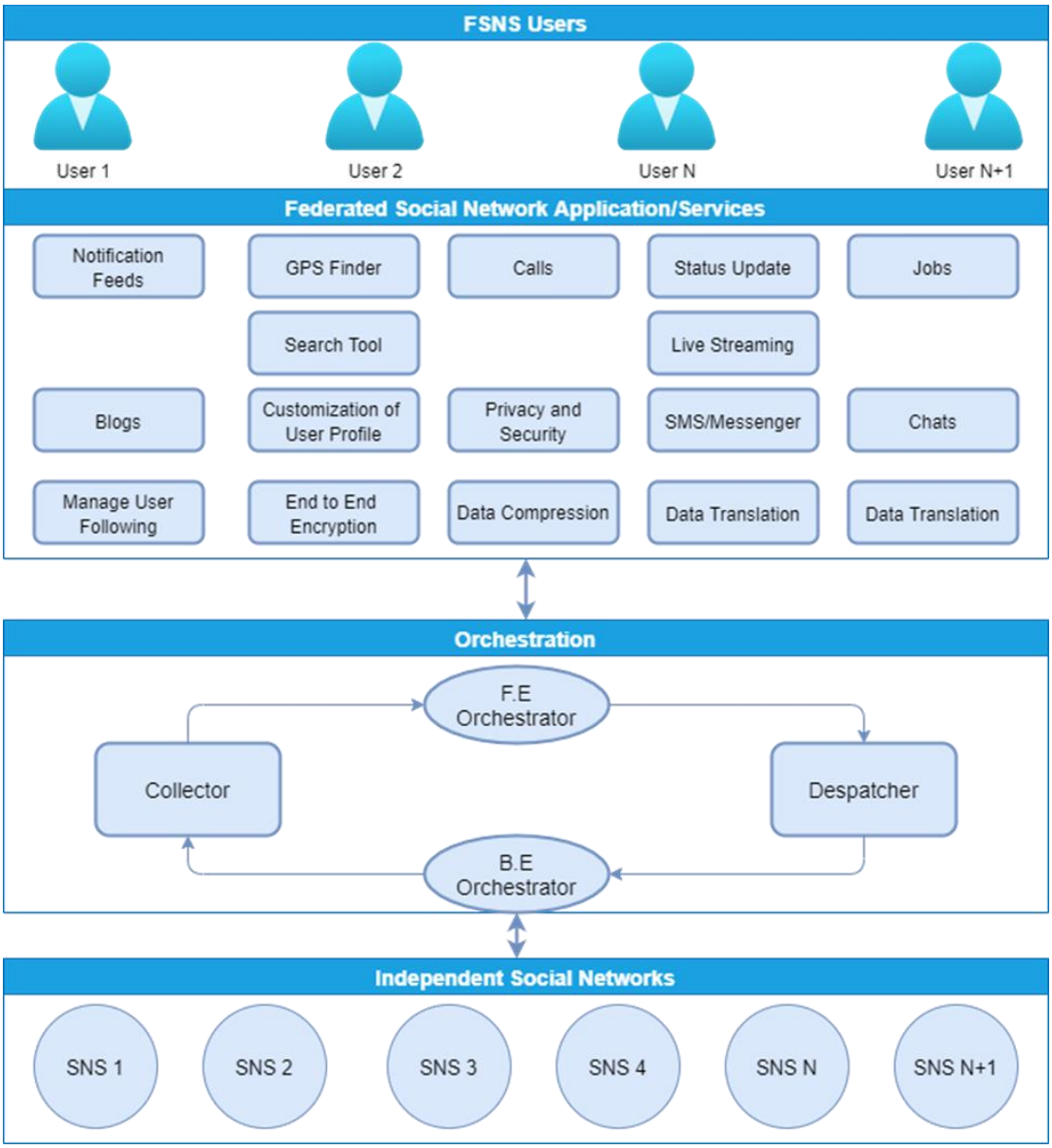


Figure 5.4: High-level architecture of the federation of social networking sites

Table 5. 1: Components of the high-level architecture

Component	Description
User	Those registered to the FSNSs
Source SNS	Source social network site

Independents SNS	Any independent and specialised SNS like Twitter, WhatsApp, etc.
Orchestration	Main module responsible for federating social network sites
Back-End (BE) Orchestrator	Responsible for routing messages/commands/information/data from the source SNS to the collector. AND Responsible for routing messages/commands/information/data coming from the despatcher to the destination SNS.
Collector	An orchestration module responsible for interpreting the packet received from the BE orchestrator, appends the appropriate destination federated social network application/service then send it to the FE orchestrator for routing.
Dispatcher	An orchestration module responsible for interpreting the packet received form the FE orchestrator, appends the appropriate destination SNS then send it to the BE orchestrator for routing
Front-End (FE) Orchestrator	Responsible for routing messages/commands/information/data from the federated social network application/service to the dispatcher. AND responsible for routing messages/commands/information/data coming from the collector to the destination federated social network application/service
Presentation	This is the presentation to the end user of federated social network services or applications. The presentation layer also supports data encryption, translation, compression and formatting to enhance security and interoperability between different data formats and devices.
Federated Social Network Applications/Services	All federated services presented to the end-user independent of its source. When a user invokes such service, dependent on his history, the real social network at the backend is transparently invoked, through the orchestration module and the service is consumed by the user.

5.3.2: Establishing the Laws of Interaction that Govern the theory

The laws of interaction are the detailed principles that guide how the units identified in the first stage should interact. At this juncture, the contribution and interactions of the identified framework units from Stage 1 are explored. (see Figure 5.5 below.)

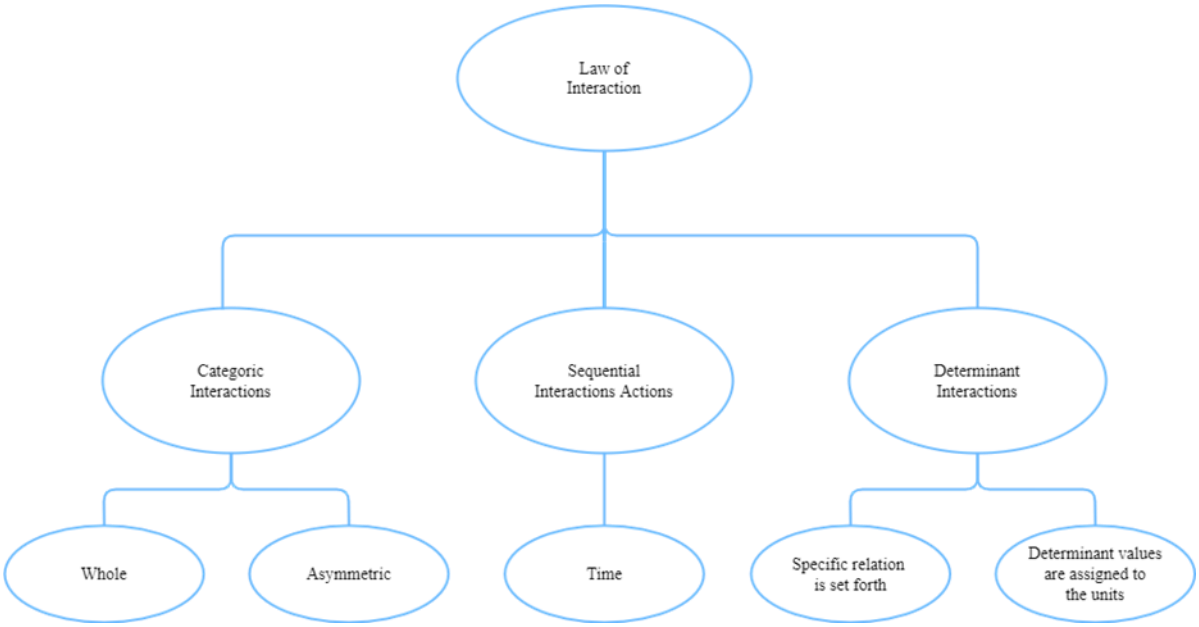


Figure 5.5: Laws of interaction

The law of interaction is divided into three categories:

Categoric interaction stresses the association of values in different units, where the association can take a present or absent form, depending on the values in the units. The values of one unit should have a relationship with the value of the other unit. There is no order of appearance of units (asymmetric), and when they can be described by the "is associated with" phrase, then these units do not need to be distinguished when used since they are contributing to one common goal, therefore taken as one.

Sequential interaction: The units are allocated and given time dimensions. The phrases usually used in sequential interactions are "succeeded by" or "preceded by".

Determinant interaction relates the determinant values of one unit of the theory with the determinant values of another unit; it analyses the values of the units to ascertain if there are similarities or relationships. The relationship of the values in question is either set forth or can be assigned.

5.3.2.1: Use Case Scenario on Laws of Interaction

Laws of interaction are lawful statements that express an association, linkage or connection between two or more units (Fry and Smith, 1987). The study considered all three types of laws of interaction in designing the framework. In that regard, the communications in the federated social networking sites depend on the category of those registered to the federated social networking sites; in this research, all registered students at an institution with the FSNS are members by default. In addition, communications in the FSNS are innately sequential, i.e., a user must be registered to connect, and communication is by request, whereby the orchestrator fetches instructions and direct the request to the correct destination for execution. For example:

(i) User A wants to chat with User Z who is registered on WhatsApp and Facebook

(User A is a user with a computer installed with an android emulator (e.g., *Bluestacks*) application,

registered to the FSNS. **User A** is also registered to WhatsApp and Facebook for chatting**)**

// User A: Click on chat from User A's device and select user Z

//FE Orchestrator: Get user request and send it to the Dispatcher

//Dispatcher: Interprets the user request, realises that user Z is registered on WhatsApp and Facebook, then asks the BE Orchestrator to transparently invoke the ***chat app that is quicker to respond*** *to be used by Z and open communication between User A and user Z*

//BE Orchestrator: Invokes Facebook ***as the faster chat app to be used by Z since it does not need an intermediator for communication****, targeting user Z*

//User A: Start chatting with Z

(ii) **User A wants to chat with User X who is registered on WhatsApp**

(User A is a user with a smartphone, registered to the FSNS, **User A is** also registered to WhatsApp and Sasai for chatting)

*//**User A**: Click on chat from **User A's** [on] my device and select user X*

//FE Orchestrator: get user request and send it to the Dispatcher

*//Dispatcher: Interprets the user request, realises that user X is registered on WhatsApp, then ask the BE Orchestrator to transparently invoke WhatsApp and open communication between **User A** and user X*

//BE Orchestrator: Invokes WhatsApp targeting user X

*//**User A**: Start chatting with X (through the collector from source, through the dispatcher from services/applications)*

The last law of determinant interaction states that it "relates determinant values of one unit of the theory with determinant values of another unit" (Lynham, 2002, p. 250) where, in this case, the determinant values are the SNSs sources, whereby if users are registered on one of the SNSs included in the FSNS as well as on the FSNS, they are able to connect and participate in the services.

The use cases (figure 5.6 to 5.14) below detail the interactions within the prospective framework. The table 5.2 presented before the actual use cases explains what is happening in every use case that follows:

Table 5. 2 Use case descriptions

Use case	Description
USER A has a smartphone, is registered on the FSNS, and is also registered	**Scenario 1: User A wants to chat with user X who is registered on WhatsApp** • User A: Click on chat from User A's device and select user X • FE Orchestrator: Get user request and send it to the Dispatcher

on WhatsApp and Ayoba for chatting	• Dispatcher: Interprets the user request, realises that user X is registered on WhatsApp, then ask the BE Orchestrator to transparently invoke WhatsApp and open communication between User A and user X • BE Orchestrator: Invokes WhatsApp targeting user X • User A: Start chatting with X (through the collector from source, through the dispatcher from services/applications)
	Scenario 2: User A wants to chat with user Y who is registered on Ayoba • User A: Click on chat from User A's device and select user Y • FE Orchestrator: Get user request and send it to the Dispatcher • Dispatcher: Interprets the user request, realises that user Y is registered on Ayoba, then asks the BE Orchestrator to transparently invoke Ayoba and open communication between User A and user Y • BE Orchestrator: Invokes Ayoba targeting user Y • User A: Start chatting with Y (through the collector from source, through the dispatcher from service/applications)
	Scenario 3: User A wants to chat with user Z who is registered on WhatsApp and Ayoba • User A: Click on chat from my device and select user Z • FE Orchestrator: Get user request and send it to the Dispatcher • Dispatcher: Interprets the user request, realises that user Z is registered on WhatsApp and Ayoba, then asks the BE Orchestrator to transparently invoke the **recently used** chat app by Z and open communication between User A and user Z • BE Orchestrator: Invokes Ayoba **as the recently used chat app by Z**, targeting user Z • User A: Start chatting with Z
1. User A has a computer with an android emulator installed (e.g., *Bluestacks*) application, is registered to the FSNS, and also registered to WhatsApp and Facebook for chatting	**Scenario 1: User A wants to chat with user X who is registered on WhatsApp** • User A: Click on chat from User A's device and select user X • FE Orchestrator: Get user request and send it to the Dispatcher • Dispatcher: Interprets the user request, realises that user X is registered on WhatsApp, then ask the BE Orchestrator to transparently invoke ***Bluestacks*** **to open** WhatsApp and open communication between User A and user X • BE Orchestrator: Invokes WhatsApp targeting user X • User A: Start chatting with X (through the collector from source, through the dispatcher from services/applications)
	Scenario 2: User A wants to chat with user Y who is registered on Facebook • User A: Click on chat from User A's device and select the user Y • FE Orchestrator: Get user request and send it to the Dispatcher

	• Despatcher: Interprets the user request, realises that user Y is registered on Facebook, then asks the BE Orchestrator to transparently invoke Facebook and open communication between User A and user Y • BE Orchestrator: Invokes Facebook targeting user Y • User A: Start chatting with Y (through the collector from source, through the dispatcher from service/applications)
	Scenario 3: User A wants to chat with user Z who is registered on WhatsApp and Facebook • User A: Click on chat from User A's device and select user Z • FE Orchestrator: Get user request and send it to the Dispatcher • Dispatcher: Interprets the user request, realises that user Z is registered on WhatsApp and Facebook, then asks the BE Orchestrator to transparently invoke the **chat app that is quicker to respond** to be used by Z and open communication between User A and user Z • BE Orchestrator: Invokes Facebook **as the faster chat app to be used by Z since it does not need an intermediator for communication**, targeting user Z • User A: Start chatting with Z
2. User A owns a smartphone, is registered to the FSNS, also registered to Instagram and YouTube for video uploading	**Scenario 1: User A wants to upload a 2-hour video** • User A: Click on video from User A's device and select upload • FE Orchestrator: Get user request and send it to the Dispatcher • Dispatcher: Interprets the user request, realises that the video is two hours long the user is registered on YouTube, then ask the BE Orchestrator to transparently invoke **YouTube to** upload the video • BE Orchestrator: Invokes YouTube to video upload • User A: Start video uploading
	Scenario 2: User A wants to broadcast a short video • User A: Click on video from User A's device and select upload • FE Orchestrator: Get user request and send it to the Dispatcher • Dispatcher: Interprets the user request, realises that the video is short, and user is registered on Instagram, then asks the BE Orchestrator to transparently invoke Instagram and upload the video • BE Orchestrator: Invokes Instagram to broadcast • User: Start video broadcasting.
	Scenario 3: User A wants to send a short video to user X who is registered on Instagram and YouTube • User A: Click on video from User A's device and select the user X • FE Orchestrator: Get user request and send it to the Dispatcher • Dispatcher: Interprets the user request, realises that user X is registered on Instagram and YouTube, then asks the BE Orchestrator to

transparently invoke the **chat app that handles short videos** to be used by X and open communication between User A and user X

- BE Orchestrator: Invokes Instagram **as the chat app that is fit to be used by X since the video is short**, targeting user X
- User A: Start sending video to user X.

Use case 1 scenario 1

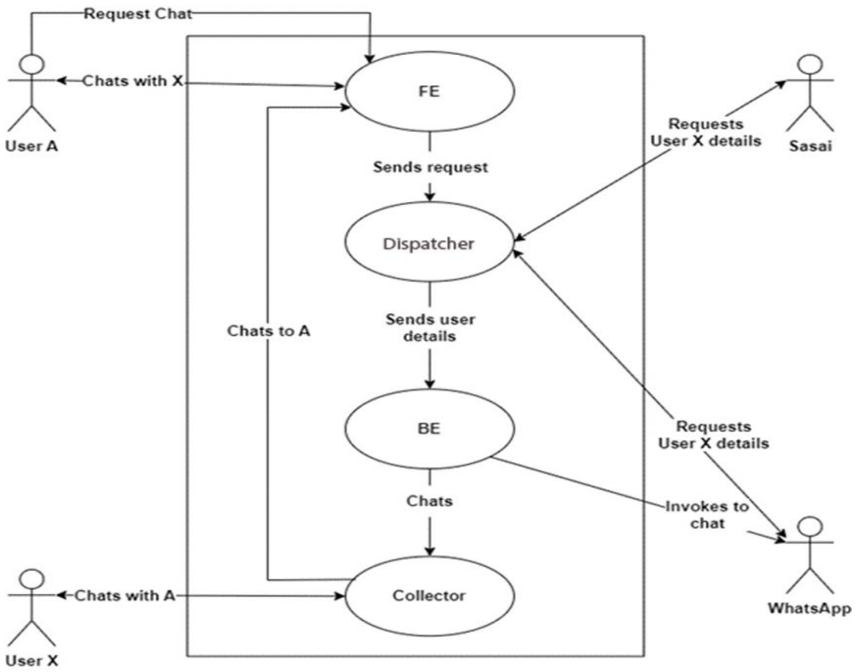


Figure 5.6: Use Case 1

Use Case 1 Scenario 2

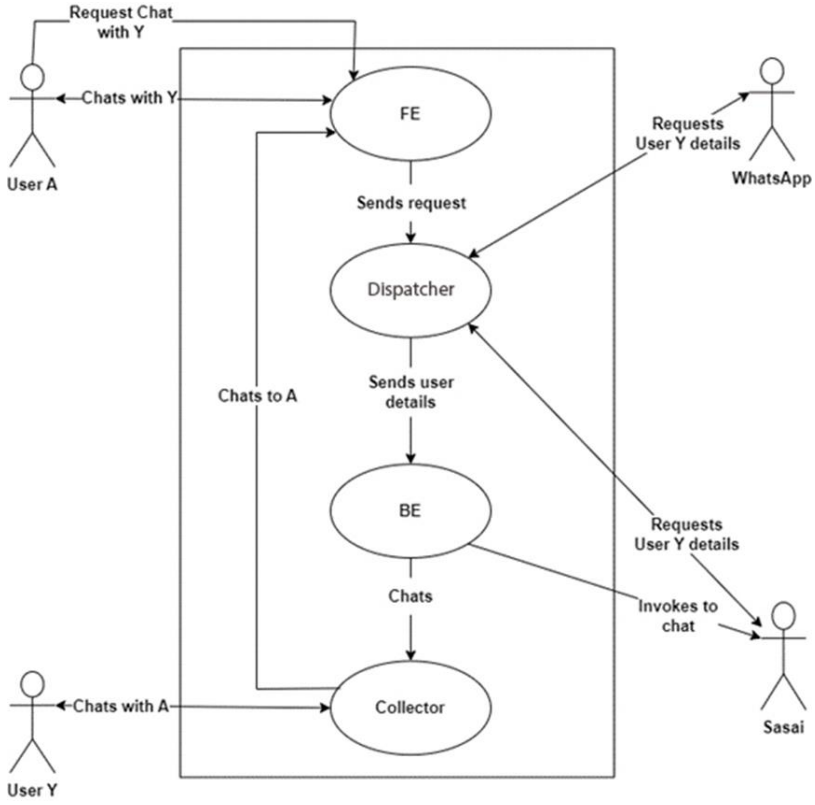


Figure 5.7: Use Case 2

Use Case 1 Scenario 3

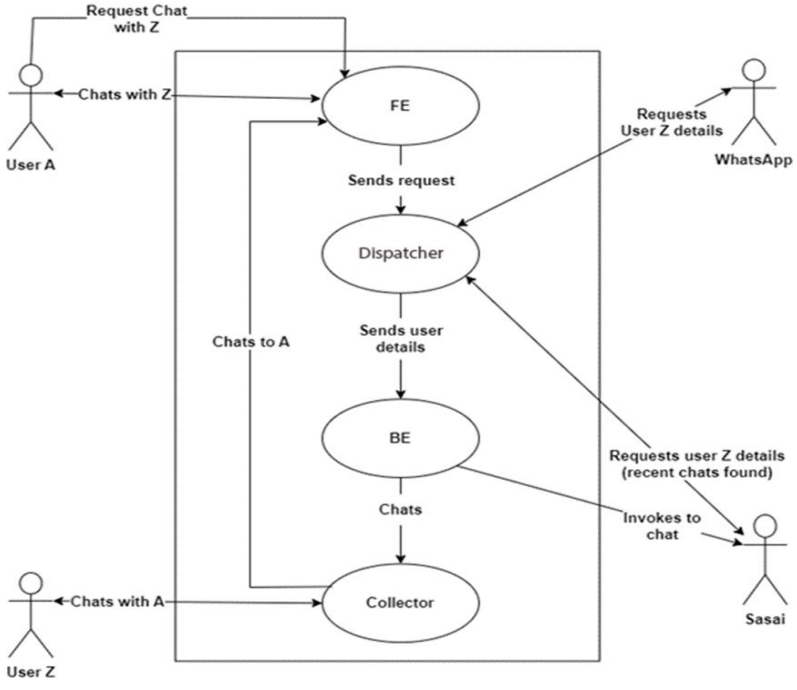


Figure 5.8: Use Case 3

Use Case 2 Scenario 1

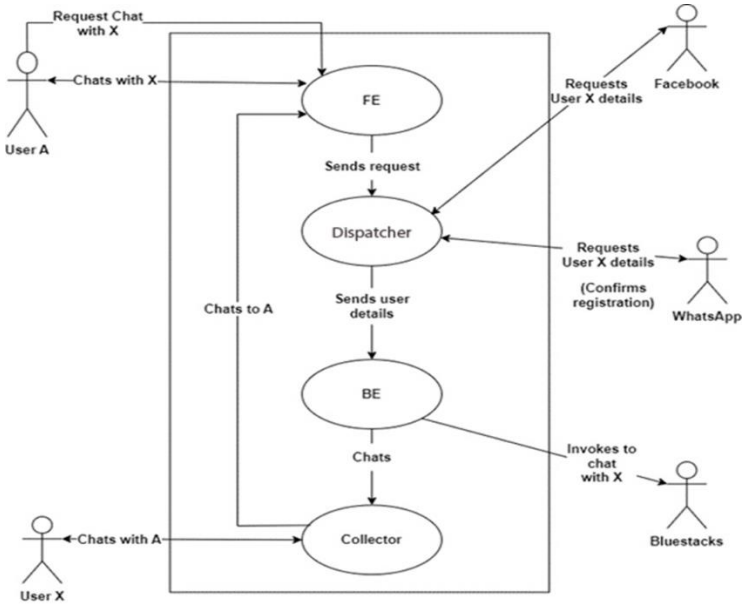


Figure 5.9: Use Case 4

Use Case 2 Scenario 2

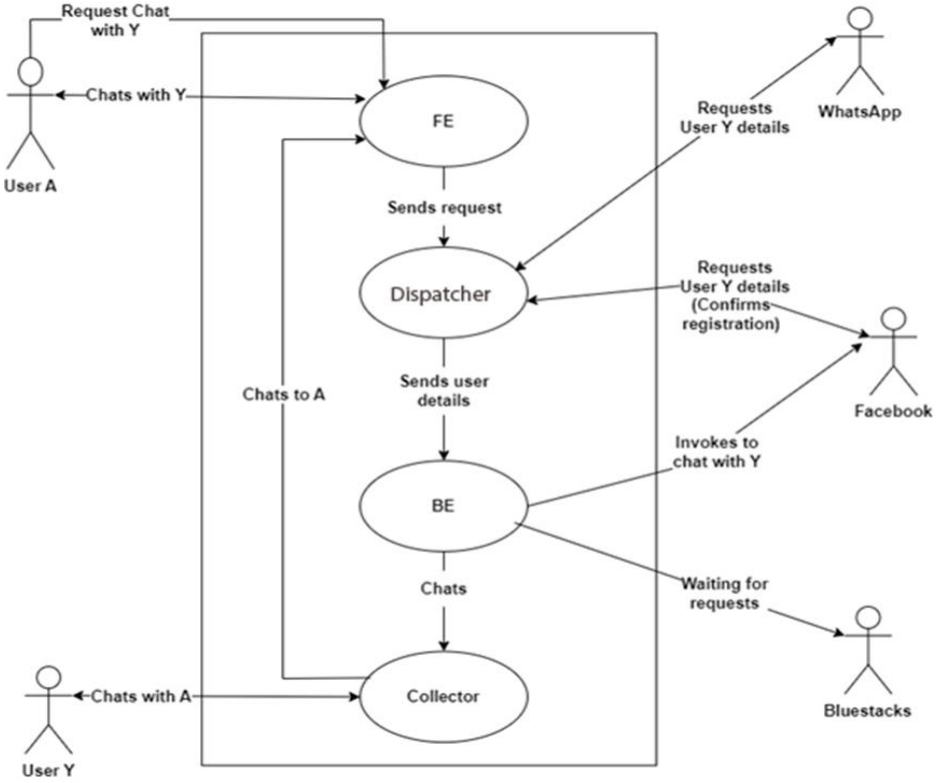


Figure 5.10: Use Case 5

Use Case 2 Scenario 3

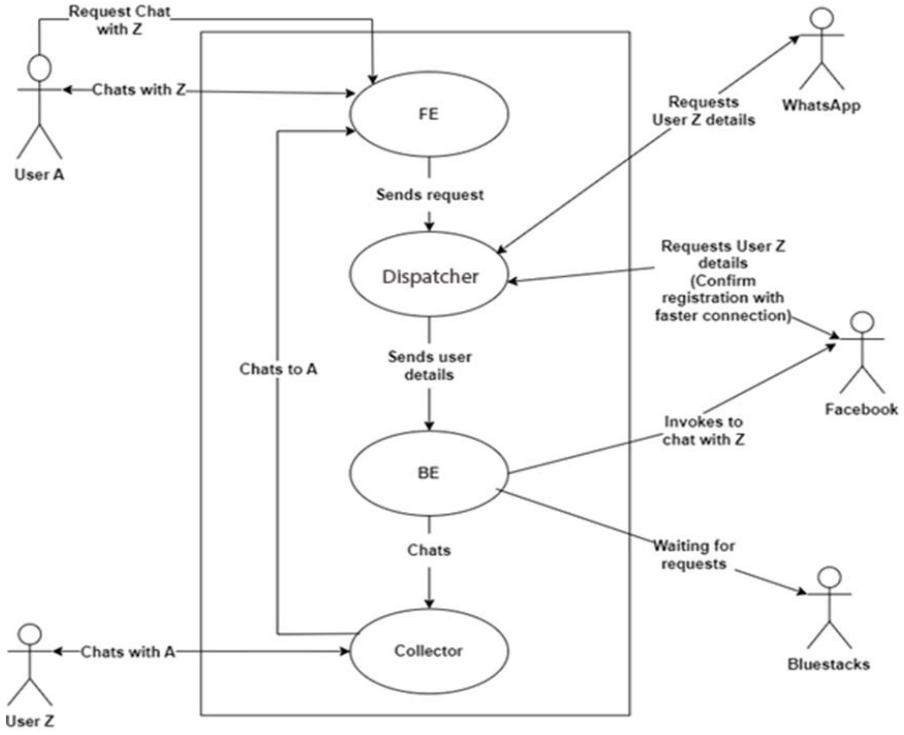


Figure 5.11: Use Case 6

Use Case 3 Scenario 1

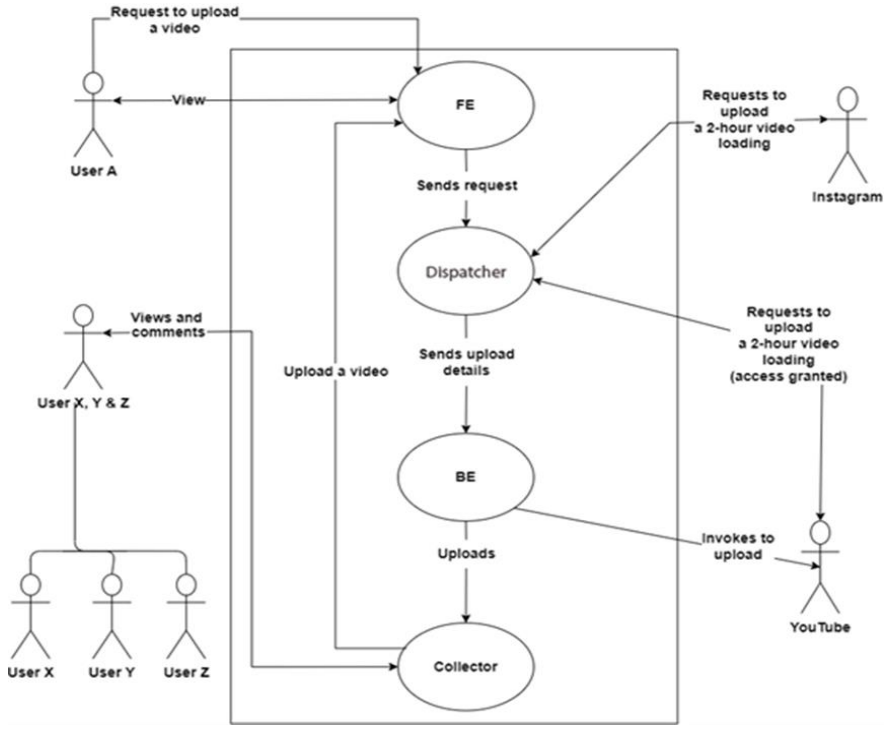


Figure 5.12: Use Case 7

Use Case 3 Scenario 2

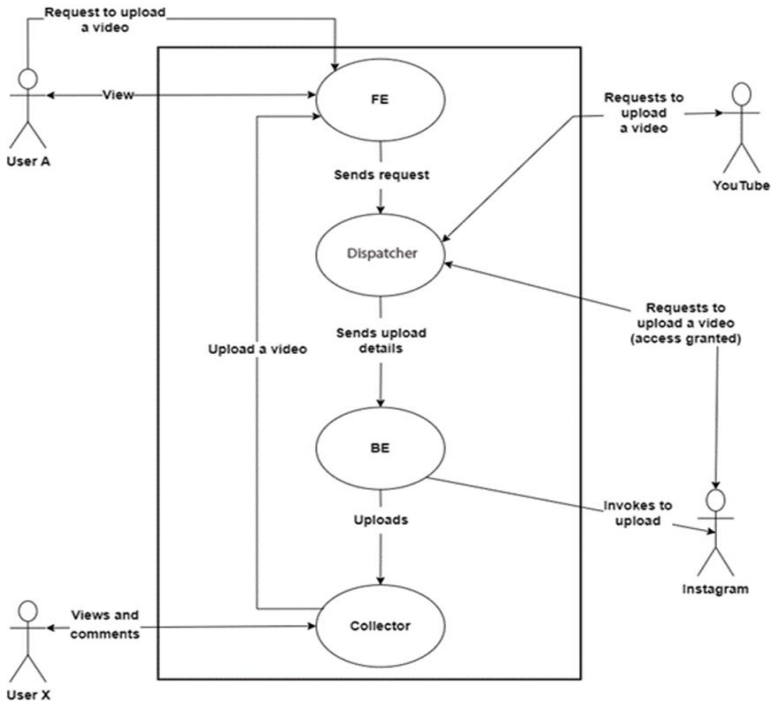


Figure 5.13: Use Case 8

Use Case 3 Scenario 3

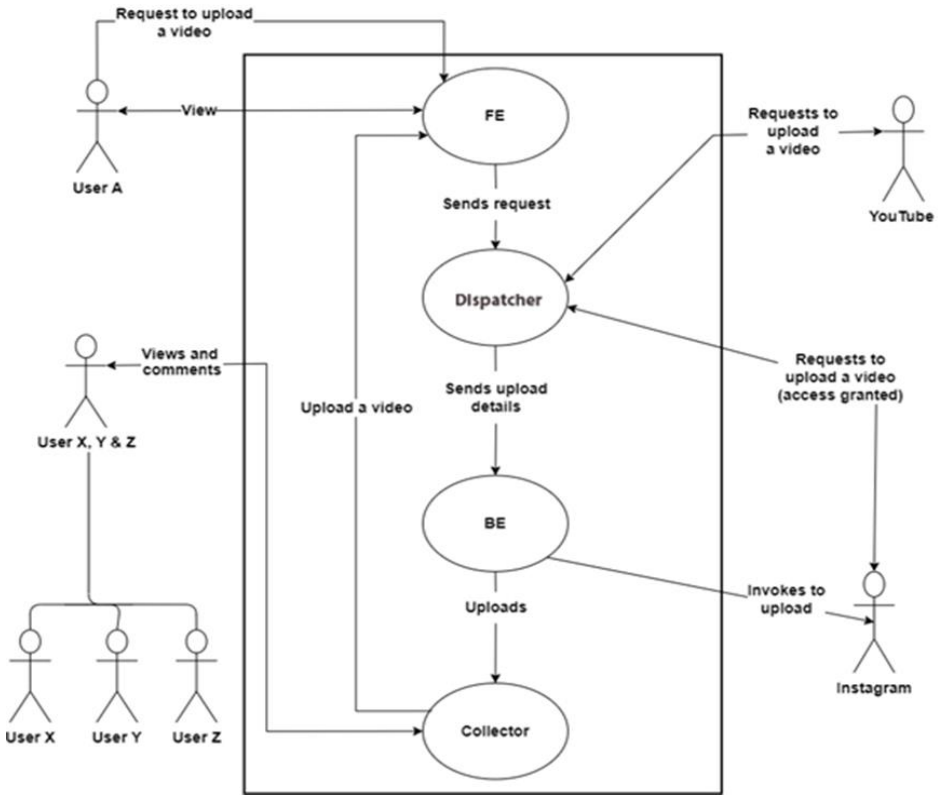


Figure 5.14: Use Case 9

5.3.3: Determining boundaries of the theory

The boundaries of a theory are the borders that confine the realm of influence, to what extent the theory should operate, what it involves and what it excludes. The boundaries of the theory elucidate the boundaries of the environment within which the theory is expected to hold, as explained by Dubin

(1978) in Lynham (2002). Hence, researchers must clearly define such boundaries when designing a framework to reach its intended goal. Crucially, the study notes that the world of technology is very broad, and if we fail to draw explicit boundaries, the proposed framework could confuse students instead of helping them. The two types of boundaries are:

Open boundaries: There is exchange over the boundary between the domains through which the boundary extends.

Closed boundaries: Exchange does not take place between the domains through which the boundary extends.

Once determined, these boundaries should be compared against the two-step criteria of excellence:

The homogeneity criterion: Combines the first two steps of theory building, where it requires that the units employed in the theory and the laws that govern their interaction should satisfy certain boundary-determining criteria.

The generalisation criterion: Does not limit the domain in the same boundary, which means that the domain might be big enough to provide a theory with a more generalised picture of the context, which may, in turn, make it difficult for users to understand the theory developed.

As regards the two types of boundaries given by Dubin, in this study, the *open* boundaries are the social networks someone might join. One student might join many social networks, but these should be *closed* in one federated social networking site. The study designed a flow chart demonstrating the flow of information in an FSNS, to which every student is required to have subscribed and also be subscribed to one or more social networking sites.

5.3.3.1: Flow chart of the activities in the framework

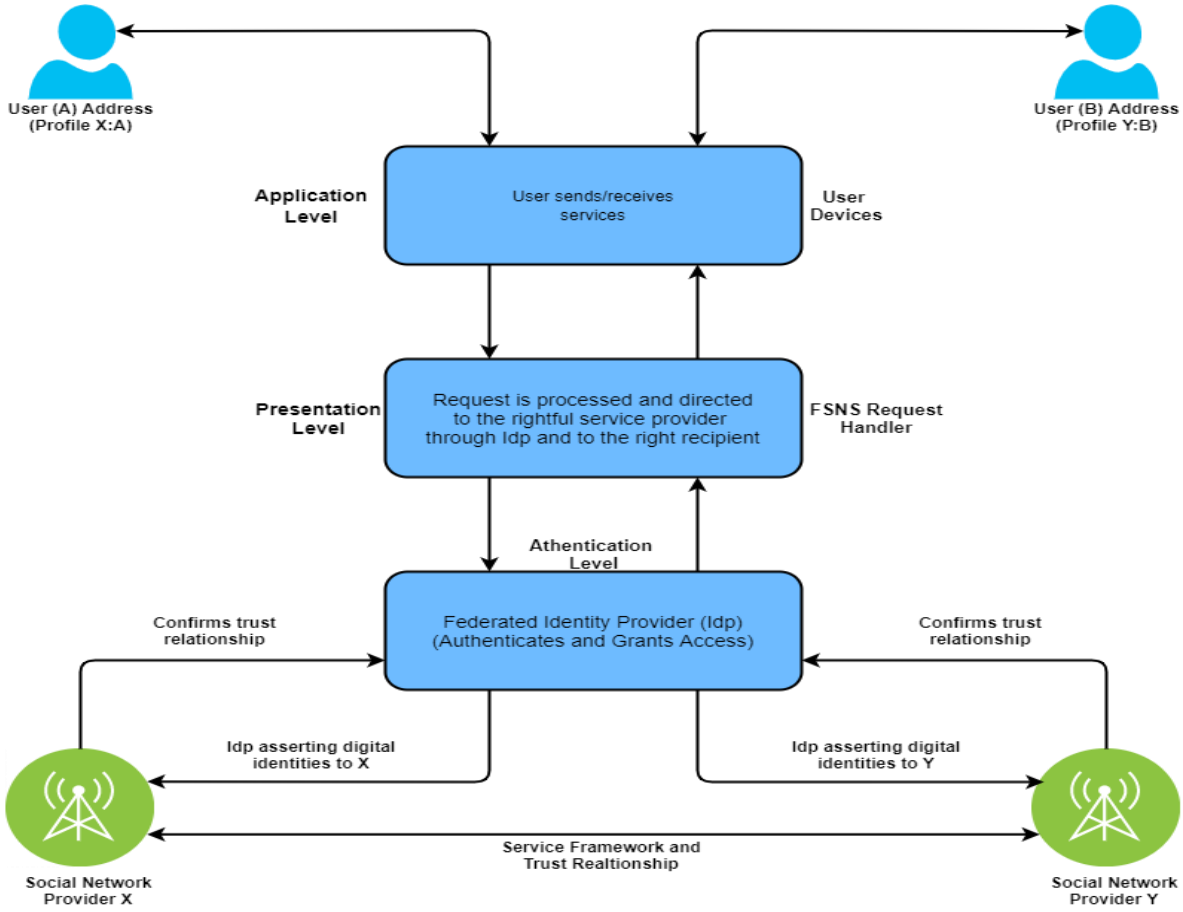


Figure 5.15: Flow chart

The flow chart in figure 5.15 portrays the importance of an applicable type of security being implemented at every stage. For example, end-to-end encryption can be implemented for user messages. The requirements for the FSNS request handler display some software firewalls that help filter unintended messages to pass through and some intrusion detection systems (IDS)—both the host-based IDS and network-based IDS. These are some of the measures that can support the prevention of attacks on the network, with the assumption that each source SNS has its security measures.

The Application Layer

This layer provides an interface between the social media network application and the user. Therefore, it provides direct services from different FSN sites to the end users through enabled features such as live messaging, streaming, status updates and blogging, which can be taken as units from the domain knowledge, the original social networking sites. At this stage, the user forwards, receives and manages communication files or content through protocols such as SMTP (for messaging), FTP (file transfer) and HTTP (for web-based social networking services). Either or both the rules and syntax of communication among various FSN sites are established at this level to ensure smooth communication. The users' communication devices implement this layer.

Presentation Level

The FSNS request handler is responsible for data formatting, encryption, compression and translation.

It converts data sent from the application layer into a format compatible with the destined FSNS as well as for easier transportation. In addition, it encodes data to an agreed standard for easier translation. The handler also enforces security mechanisms for data transmission through end-to-end encryption as well as encrypting user login details and account information prior to transmission. On the other (receiving) side, it decrypts the message details, making it available for the destined user. The functions at this level are placed in the software library, which is accessible for different applications although connecting to the same FSNS platform. Data compression is enforced to ensure the reduction of file sizes on video and audio; hence, bandwidth is also reduced.

Authentication Level

The Federated Identity Provider (FIdP) is responsible for asserting the digital identities of different trust domains (social networking sites). It enforces a trust relationship among different domains or network service providers based on the trust and service framework among these service providers in an FSNS. The application also works as a broker by granting access control among multiple FSNSs. When an FSN user logs into a specific social network application, the service provider communicates with the IdP for user authentication and authorisation through protocols such as *Open-Sourced Security Assertion Mark-up Language* (SAML), *OpenID Connect* or *OAuth*. Single Sign-On (SSO) is one of the important features of identity federation, where the system provides a single credential across various FSNSs.

5.3.4: Specifying System States of the theory

The system state is a condition of the system being modelled, which can be represented as inputs, processes and outputs of the theory (Mahlangu, 2020). System state can be broken down into three features:

- All units of the system have characteristic values.
- The characteristic values of all units are determinant.
- This constellation of unit values persists through time.

When identifying the system states of the theory, three important criteria must be followed by the research so that the output FSNS4eL would be whole. The criteria include inclusiveness, persistence and distinctiveness.

- Inclusiveness requires all pertinent units of the system to be included in the system state since they have a value or distinctive range of values that contribute to the state of the theory.
- Persistence means that the system state has a state life and should persist through a significant period.
- Distinctiveness requires that individual units contain determinant values which can be measurable and distinctive values for the system state (Lynham, 2002; Matlock III, 2012).

The FSNS4eL is proposed to aid students in their eLearning activities, thus the main stakeholders in

the system are the users (students, instructors and administrators) and the learning content, notices and the technology used in the system. The specification of the system states in which our framework would operate is demonstrated in the figure 5.16 below (Mahlangu, 2020):

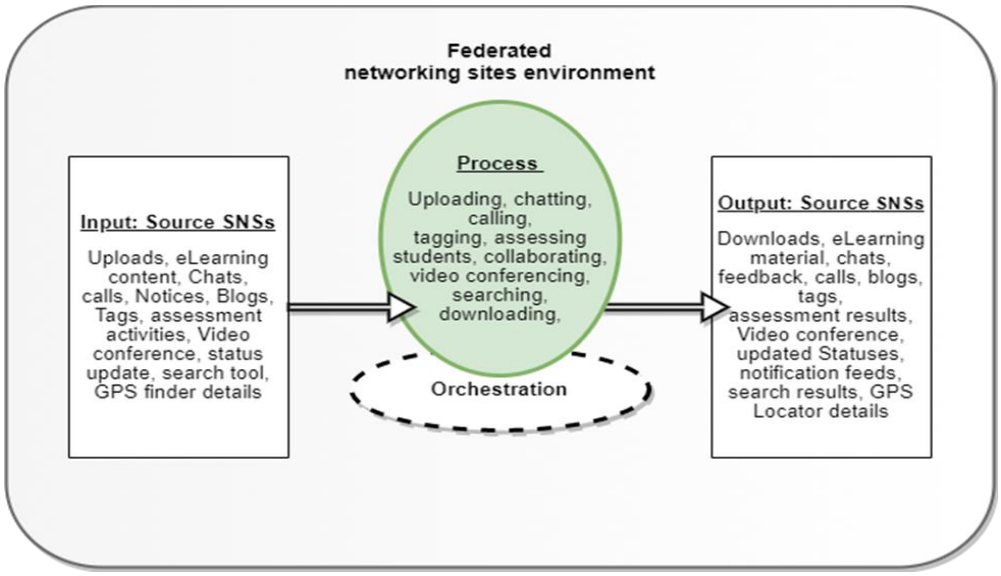


Figure 5.16: FSNS4eL system states

If the request is sent from the user through the FSNS, it is accepted by the orchestration part, where the front-end orchestrator accepts the request from the user. It then routes the messages/ commands/information/data from the Federated Social Network Application/Service (user interface) to the dispatcher for interpretation of the packet received from the FE orchestrator. Further, it appends the appropriate destination SNS and then sends it to the BE orchestrator for routing messages/commands/information/data coming from the dispatcher to the destination SNS. The request (response) from the source SNS is accepted by the BE orchestrator responsible for routing messages/commands/information/data from the source SNS to the Collector, which then interprets the packet received from the BE orchestrator and appends the appropriate destination federated social network application/service and then send it to the FE orchestrator responsible for routing messages/commands/information/data coming from the Collector to the destination federated social network application/service for users' consumption.

5.4 FSNS4eL Frameworks

A computer network is defined as a collection of computers connected in some way such that they can exchange data among themselves and other computers on the network. A network can also be defined as groups or systems of interconnected people and organisations (including schools) whose aims and purposes include the improvement of learning and aspects of well-being known to affect learning. Networking is at least two organisations collaborating for a common purpose (at least some of the time), while social networking is the use of the internet to connect users with their friends, family and

acquaintances (Australian communications consumer action network, 2010; Kumar & Deepa, 2017; Muijs, West & Ainscow, 2010).

Social networking sites are web-based services that allow individuals to: construct a public or semi-public profile within a bounded system, articulate a list of other users with whom they share a connection, and view and traverse their list of connections and those made by others within the system. Federated social networks are social networking sites aiming to integrate users through a decentralised structure, "enabling interoperability among multiple social networks in a transparent way"(Silva et al., 2017, p. 1). The study borrowed the concepts from the definitions above to produce different types of federated social network configurations to select a suitable configuration to be used as a framework for eLearning (Ellison & Boyd, 2013; Silva et al., 2017, p. 1).

We designed different types of FSNS4eL ranging from peer-to-peer to Hybrid FSNS4eL. The development process was informed by the literature, whereby the eLearning frameworks included were discussed in Chapter 4. Through discussion, we deduced that the eLearning frameworks, although designed from different perspectives and for different environments, contain three building blocks which can be derived directly or indirectly from them. These are Human Resources, eLearning Services and Technology. These building blocks were also considered during the development process of the FSNS4eL framework.

Conversely, the DSM has a two-phase principle of build and evaluate, which can be further explained in the methodology, which stresses that the proposed framework should be developed to work in the environment it was designed for. Additionally, the DSM recommends that the framework should be informed by the knowledge base, i.e., the existing literature, theories to guide the process, models, and other tools to enhance the development process. The DSM stresses the importance of those two steps for the relevance and rigour of the developed framework to be realised.

Dubin's theory development process provided a roadmap for the development of these frameworks. The process has eight stages, of which four stages were utilised in the *building* of the FSNS4eL, while the other four states would be utilised in the *evaluation* phase. The following sections examine the frameworks developed guided by the above attributes.

5.4.1 A preliminary Framework for Federated Social Networking Site for eLearning

This peer-to-peer FSNS framework is used by students, lecturers and administrators for communication and learning purposes. According to Mugoniwa and Ngassam (2021), each SNS maintains its integrity yet has the ability to pass messages to other SNSs with different types of SNSs communicating on request by users registered to the FSNS. Figure 5.17 further illustrates that a lecturer using social networking site (SNS) Z can communicate with a student (A) using SNS X. The message is written by the lecturer and sent to the student in the lecturer's address book. SNS Z realises that the student is not in SNS Z but in SNS X. It then routes the message to SNS X using the appropriate transmission protocol

as an explanation of how users of the system connect to other users in the FSNS.

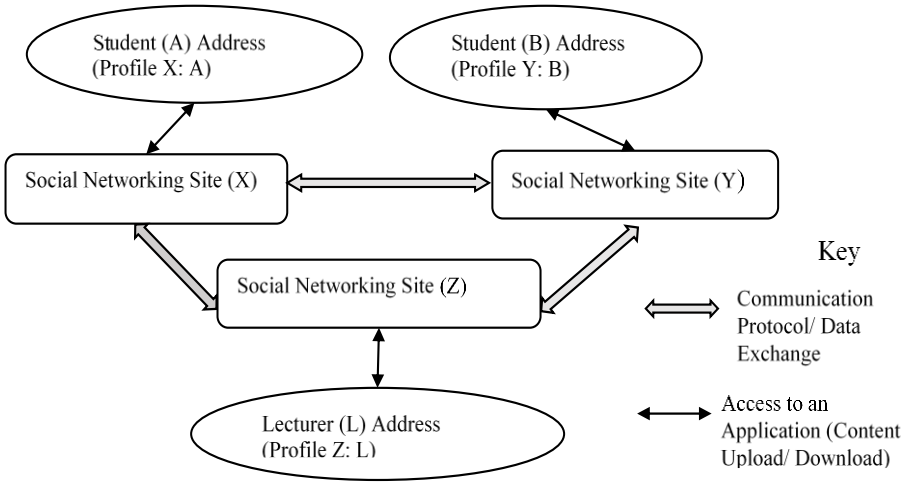


Figure 5.17:Preliminary FSNS in higher education (Mugoniwa & Ngassam, 2021, p.5)

5.4.2 Peer-to-Peer federated social network

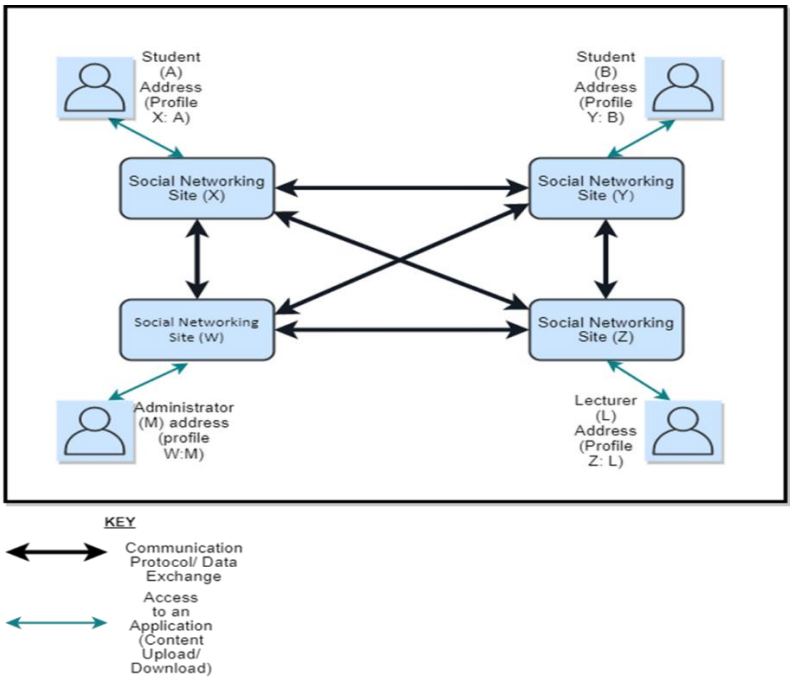


Figure 5.18: Adapted peer-to-peer FSNS (modified from Mugoniwa & Ngassam, 2021, p.5)

With a peer-to-peer federation framework, each SNS must have a mutual protocol or standardised protocol enabling them to perform mutual communication, although each SNS maintains its integrity but can pass messages to other SNSs. Figure 5.18 above shows a modified peer to peer FSNS with students, lecturers and administrators as the main actors. In the framework (figure 5.18), an administrator (M) registered to social networking site (SNS) W can communicate with a student (B) using SNS Y. The dispatcher in the FSNS interprets the request from M, realises that B is registered on SNS Y, and then asks the BE Orchestrator to transparently invoke SNS Y and open communication

between M and B using the appropriate protocols. However, in this conceptual framework, standardisation is not always achievable and might not be achieved in the near future. Moreover, there is a problem of complexity if an SNS would like to broadcast a message to many SNSs at a time and is more commonly implemented where less than ten computers are involved and strict security is not necessary (Kumar and Deepa, 2017). There also exists a challenge of SNS knowing which user belongs to which SNS to be able to route messages accordingly.

5.4.3 Client-Server FSNS

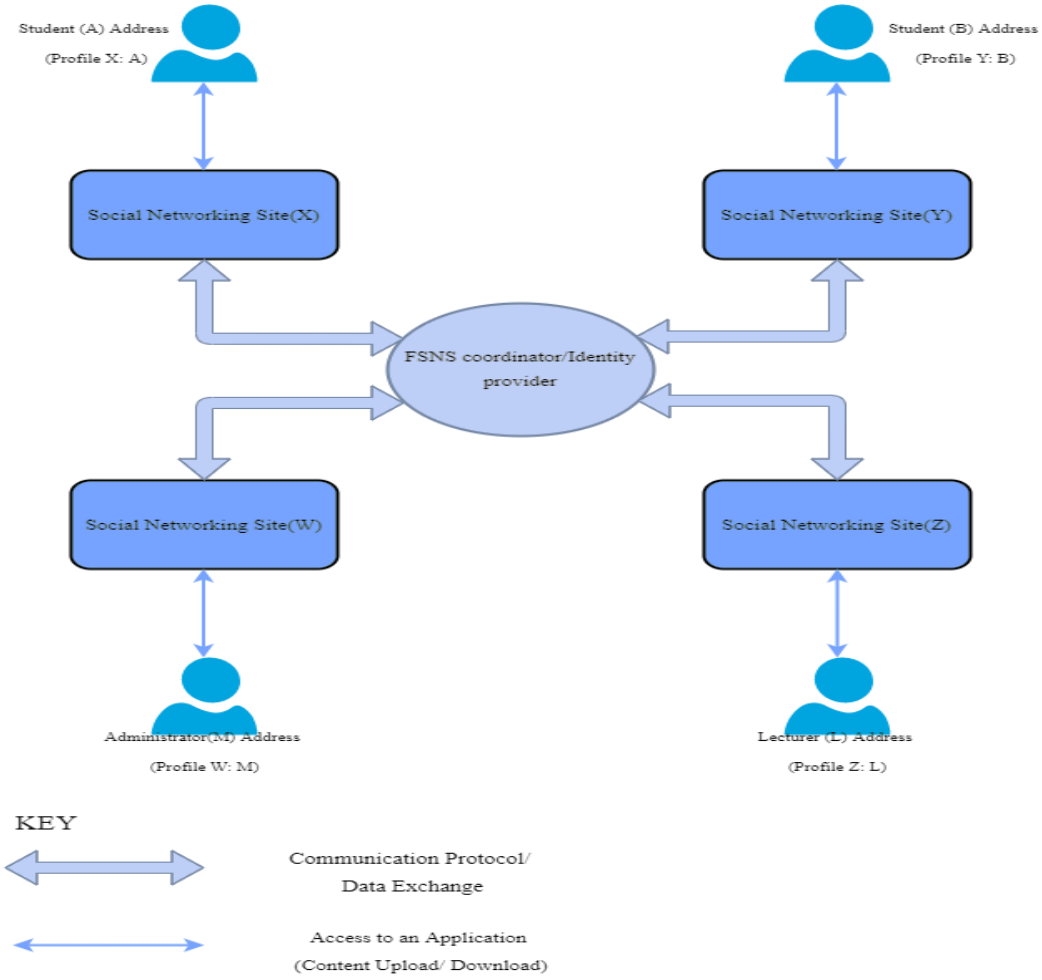


Figure 5.19: Client-to-server network adapted FSNS (modified from Mugoniwa & Ngassam, 2021, p.5)

In this framework (figure 5.19), all requests and transmissions pass through a coordination model that handles any routing from one SNS to another and even within. The FSNS coordinator has the ability to plug into any SNS and vice versa and can easily register a user in any other SNS for transmitting messages when necessary. In the framework, an administrator (M) registered to social networking site (SNS) W can communicate with a student (B) using SNS Y. The request is directed to the FSNS coordinator that deals with all the orchestration. In the Coordinator, the dispatcher in the FSNS interprets the request from M, realises that B is registered on SNS Y, then asks the BE Orchestrator to transparently invoke SNS Y and direct all requests to SNS Y, receives feedback from Y and forwards it to SNS W, thereby facilitating and controlling communication between clients M and B using the appropriate protocols.

5.4.4 Hybrid FSNS (the adopted conceptual framework)

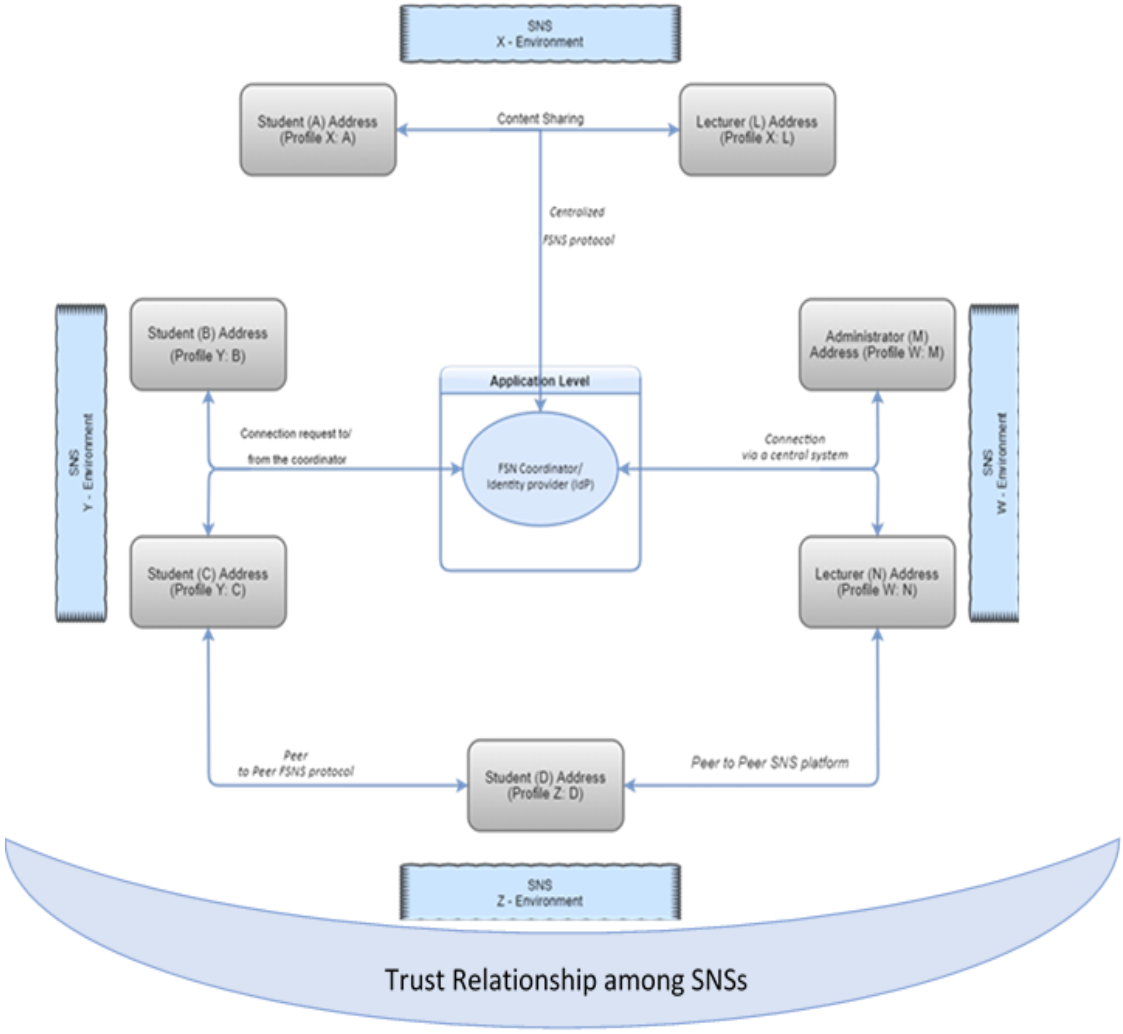


Figure 5.20: Hybrid FSNS (modified from Mugoniwa et al., 2023)

In this framework (figure 5.20), some requests and transmissions pass through a coordination model that handles any routing from one SNS to another and even within. The FSNS coordinator has the ability to plug into any SNS and vice versa and can easily register a user in any other SNS for transmitting messages when necessary. However, each SNS maintains its integrity yet has the ability to pass messages to other SNSs. The framework is a combination of a peer-to-peer and client-to-server framework; when the communication involves fewer users, the peer-to-peer takes over, and with communication among many users with different SNSs, the client-to-server is used. Like in the client-to-server framework, an administrator (M) registered on the social networking site (SNS) W can communicate to students (A) and (B) through the FSNS coordinator. The request is directed to the FSNS coordinator that manages all the orchestration. In the Coordinator, the dispatcher in the FSNS interprets the request from M, realises that A is registered on SNS X and B is registered on SNS Y, then asks the BE Orchestrator to transparently invoke SNS X and SNS Y and directs all requests to SNS X and Y, and receives feedback from X and Y, then forwards it to SNS W, thereby facilitating and controlling communication of client M with A and B using the appropriate protocols. The FE

orchestrator is responsible for routing the messages/commands/information/data to the destination federated social network application for users M, A and B. However, student C and student D can have a communication connection using the principle in the peer-to-peer framework without the use of central coordination control. The main modules of the diagram are explained below.

5.4.4.1 SNS Environment

Refers to the social networking application environment provided by a specific social networking site, within which users are registered to communicate or connect and share content of special interest.

5.4.4.2 Address Profile

The user identity, which is the social networking site after being registered to that specific site. Thus enabling the user to enjoy the facilities of a specific SNS, such as content sharing among SNSs users. Every registered user has a unique profile.

5.4.4.2 Peer-to-Peer SNS Protocol

A standard of communication dedicated between two or more social networking sites that enforce independent communication and procedures without a central controlling/coordinating system. The terms and conditions are independently agreed upon and established between interested social networking sites.

5.4.4.3 The Application Layer

The federated social networking layer provides an interface for interaction between the users and the system through features such as video calls, chats, messaging and finding friends.

5.4.4.4 Centralised FSNSs Protocol

A communication standard established among various social networking sites platforms, but through a centralised system which involves an FSNSs coordinator and FSNSs identity provider. Every federated social networking request is done via a central server

5.4.4.5 FSNSs Coordinator

Responsible for routing messages, commands, data or request to and from various Federated Social Network Services. It is the heart of the centralised communication protocol.

5.4.4.6 Trust Relationship

Created through strong business values and ethics that bind FSNS sites in the provision of much-needed service.

5.5 Validation of the Conceptual Framework

According to Lynham (2002)**,** the outcome of the framework can be measured according to five criteria, namely rigour and exactness, parsimony, completeness, logical consistency and the degree of conformity and combination of the units. This study utilises the first four criteria in search of the validation of the framework. The framework was distributed for expert review to seek the expert

opinion in order to validate the conceptual framework (Mahlangu, 2020). Table 5.3 presents the criteria used for validation, the definition and the application so that the experts would have one common interpretation in their evaluation.

Table 5. 3: Criteria for framework validation

Criteria	Definition	Sources	Application
Relevance	Does the framework address the needs/objectives of the research/study?	(Hevner et al., 2004)	The framework should allow students, lecturers and administrators to send and receive information using the platform.
Usefulness	The net benefits the users gain from the framework.	(Hevner et al., 2004)	The users should be barred from spending a lot of time on general SNSs.
Rigour and exactness	The appropriateness of the method to answer the questions / the quality or state of being very exact, careful, or with strict precision or the quality of being thorough and accurate.	(Cypress, 2017; Gill and Gill, 2020)	The transmission of data will be assisted by the addresses of each user; no message should reach the wrong destination.
Parsimony	Achieves good levels of predictive and explanatory power in relation to its focal phenomena using a small number of constructs, associations and boundary conditions (simplicity) / Is the framework practical and the stages involved simple enough to be readily understood by the users?	(Rajendran, 2015, p.), (Lincoln and Lynham, 2011)	The framework was designed in such a way that users can use it without problems.
Completeness	Important categories or elements should not be omitted / cover all the aspects of the particular application domain.	(Hevner et al., 2004a; Rajendran, 2015)	All the main modules are included and explained in the framework.
Logical flow/ consistency	Is the framework practical; the stages and entities involved should be clear enough and readily understood by the users and	(Esteves *et al.*, 2016)	The users should be registered on one or more SNSs, the users should be registered to the FSNS, and should be a

	also should hold one value at a point in time.		student, lecturer or administrator at Midlands State University.

5.6 Summary

This chapter introduced and deliberated on how a framework can be developed using the DSM in conjunction with the differing views on theory development. Different tools like use cases, flow diagrams, and the framework model that aided in developing the conceptual framework for this study were presented. These tools might shape the nature of framework development when combined with guidance from the theories discussed and the eLearning frameworks from the extant literature.

The chapter demonstrated that the development of a conceptual framework should be guided by the first part of the four-step process of Dubin's theory-building method: identification of units, the laws of interaction, determining the boundaries and identifying the system states.

The conceptual framework was designed to provide a blueprint and structure of how the final framework should look after the data had been gathered and experts provided their views. This would guide the study in data collection and analysis. The study identified the main role players as the users, SNSs and the content/messages/calls in the FSNS conceptual framework.

The chapter also discussed the types of network configurations (peer-to-peer, client-to-server, and a hybrid) that could be adopted in the framework design, outlined their advantages and disadvantages, and the best (hybrid) network configuration was chosen and implemented as a conceptual framework for FSNS4eL. The chapter also investigated how the framework could be validated, providing the parameters to be used by the experts as a guide to validating the framework. Therefore, SRQ3, posed at the beginning of this chapter, was answered satisfactorily, and the research objective was successfully met. The next chapter discusses the empirical data-gathering methodology and how it was analysed.

Chapter 6 : Data Collection

6.1 Introduction

The preceding chapter presented the framework development process and the theory to guide the framework development, and in the process, presented the different tools that aided in the framework development. In addition, the previous stage of the research highlighted the different types of FSNSs that can be used in learning institutions before settling on the adopted HFSNS4eL.

Therefore, this chapter articulates the philosophy within which this study is embodied, providing the platform upon which the methodological tools for the research were based. The chapter discusses the methodology that informed the collection and analyses of data, outlining the approach used to conduct the survey and describing the approach to the experts' contribution.

In this chapter, the study addresses SRO4: *To evaluate and validate the proposed conceptual FSNS4eL and then deliver an improved version for further adoption*. The chapter describes the first step towards achieving the stated objective and further, outlines the plan/design followed to successfully evaluate and improve the FSNS4eL presented in Chapter 5.

Chapter 6 explores the research philosophy guiding this study and then focuses on the design science research (DSR) paradigm as the focal point of framework development methodologies. In addition, the research methodology and the research strategy are presented, as well as the targeted population and the sampling techniques used before the research sample was declared and how that decision was made. The chapter presents the data-gathering techniques, followed by how data analyses were undertaken and lastly, the ethical considerations adhered to by the study. Thus, posing SRQ 4: *How can federated SNSs be validated and improved to gain an improved version that could be used as an eLearning tool in universities?*

6.2 Research Philosophy

A set of beliefs about how data are collected and analysed within a certain phenomenon is defined as a research philosophy (Kaushik & Walsh, 2019a). Therefore, a research methodology, beliefs, norms and values are grounded in a specific philosophy. The present study's philosophy links its research methodology, ontology and epistemological perspective. The chapter further discusses how ontological and epistemological perspectives influence research methodology by providing an understanding of

different research methodologies for this study (Kivunja and Kuyini, 2017). Ontology explores the underlying beliefs of a researcher as it tries to uncover a sense of the social phenomenon being investigated. Methodology refers to a combination of study designs, methods, processes and approaches utilised in an investigation to obtain a worldview (Caetano *et al.,* 2018). Axiology provides an ethical basis within which research is planned and executed; it defines and evaluates appropriate or inappropriate behaviour in the research process (Caetano *et al.,* 2018; Kaushik and Walsh, 2019).

Considering a study classified under information and communication technology, Mkansi and Acheampong (2012) explain that four philosophical paradigms best suit this field. These include positivism, critical realism and pragmatism. Positivist philosophy is founded on the universality of laws; it argues that facts are based on observable, measurable, replicable and verifiable laws. This philosophy emphasises that the social world should be examined in the same way the physical world is conducted. More so, it asserts that every phenomenon has a scientific explanation attached to it (Comte, 2015). Quantitative methods of data gathering and analysis, as well as an experimental approach, form the basis of positivism. In this philosophy, we are unaffected by the inquiry process and subjective and abstract knowledge are denied. Hypotheses confirm the relationship between provided datasets deductively.

Critical realism is a relatively new philosophical perspective, similar to positivism, as it emphasises scientific processes to discover new knowledge. However, it represents a synthesis different from positivism in that it explains what people see or experience according to the underlying truth. Critical realists suggest that reality is external and independent of people. It provides two levels of comprehending the universe which are; events and consciousness which are used for reasoning in a backward manner to discover the underlying truth.

In contrast, interpretivism is interested in socially produced reality as opposed to objectively established truth. This approach attempts to unearth a deep understanding and interpretation from the respondent's viewpoint since the philosophy argues that people are unlike artefacts because they create meaning. In information systems, the goal of interpretive research is to create new meaning through an in-depth understanding of a social system. In that way, interpretivism is highly associated with qualitative research design.

Pragmatism is the belief that any idea is useful if it contributes to people's actions. The philosophy further holds that a proposition is valid if it performs satisfactorily and that impractical ideas should be avoided in a research process. Pragmatism aims to reconcile subjectivism, objectivism, and fundamental and rigorous understanding with a variety of experiences. This is achieved through the evaluation of ideas, opinions and hypotheses. Thus, the philosophy takes a pluralist approach to combining both positivist and interpretivist philosophies as it sees reality through subjective (socially created) and objective views, which permit us to capture phenomena with duality. Importantly such

research is guided by research objectives or questions rather than methodological preferences. Therefore, research questions determine methodological preferences.

Table 6.1 below explains the questions answered by the identified philosophies in the context of information systems. The main research question is underpinned by 'what', 'why' and 'how' in an attempt to answer eLearning problems at Zimbabwean universities (Mahlangu, 2020).

Table 6. 1 Research questions and their philosophical alignment

Research Question	**Purpose**	**Research Philosophy**
What	Describe (descriptive) a phenomenon	Positivism/Interpretivism/Critical Realism/Pragmatism (Saunders et al., 2016b)
How	Explore (exploratory) a phenomenon	Critical Theory/Interpretivism (Archer *et al.*, 2013)
Why	Explain (Explanatory) of a phenomenon	Interpretivism/Positivism/Critical Realism/Pragmatism (Feilzer, 2010)

Since the present study aims to answer 'what' and 'why' questions, it adopted a pragmatic philosophy grounded on the following beliefs:

- Pragmatism is driven by purpose and knowledge (Morgan, 2014). In addition, it seeks to understand the desired changes in the world and thus act in accordance with changes. After the study recognised the fragmentation in communication through social media in higher education, the research sought to contribute to changes in the social networks' communication architecture for the benefit of higher education in terms of eLearning.

- Pragmatic epistemology assumes that the true world exists, although everyone interprets it differently, and also takes note that social experiences shape how people perceive the world (Kaushik and Walsh, 2019). As such, knowledge is always found through experience, in as much as we have more than a decade of teaching experience in higher education. Thus, said experience and in-depth understanding of the information systems teaching environment would aid in establishing much-needed facets of the adoption of FSNS for eased communication.

- Pragmatic philosophy pursues a mixed research approach which enabled this study to gather data unrestrictedly, thereby enabling the collection of varying, quality data in higher learning environments (Feilzer, 2010).

- Reality is never static as it shifts with changing times (Maarouf, 2019). In the same way, the world is not static, and information technology follows the same dimensions insofar as it is always dynamic. At present, the eLearning environment in higher education has to change to

meet the dynamic demands of all technologies, requiring continued research that would contribute to contemporary electronically based learning.

In sum, this study selected pragmatism since it allows flexibility in the research by combining multiple methodologies that provide various angles of enquiry. Indeed, it aligns with our experience in higher education, where technology has changed the landscape of educational delivery. Hence, there is a need to use a changing and continuous approach in research. Due to its pluralistic nature, pragmatism embraces even diverging perspectives or theories.

6.3 Design Science Research Paradigm

This study is motivated by design science research (DSR) in information systems (IS) theories, which are also in line with pragmatic philosophy. Design science in information systems research primarily focuses on the development/design of artefacts, functional systems, architectures or frameworks. It is an outcomes-based IS research methodology with an interest in providing frameworks and guidelines for evaluation in computer-based research projects. In most cases, it is applied in the disciplines of IS, computer science or engineering, such as algorithm development, systems interfaces, programming languages, process models and design methodologies. However, design science is not restricted to IS-related fields, as it can be pursued in many other disciplines.

Principally, design science research methodology is constructive research as opposed to an explanatory research process. In addition, DSR supports pragmatic philosophy, which aims to provide an understanding of dynamic environments and is also considered a quest for improving computer user environments. The design science research process incorporates six steps: problem motivation, definition of objectives, design and development, demonstration, assessment and communication. This study identifies with and relates itself to the design science research process model through design sciences objectives and activities.

Table 6. 2 Design science research process model

Objectives of the design science research process	**Activities**
Problem identification and motivation	-Problem enumeration -Analysis -Selecting important and relevant problems -Meta-requirements -Construct a conceptual framework
Objectives of a solution	-Creating Requirements (Implicit in relevance)

Design and development	-Suggestion Development -Synthesis -Tentative design proposals -Develop a system architecture -Analyse and design the system. -Build the system
Demonstration	-Experiment -Observe -Evaluate the framework
Evaluation	-Confirmatory evaluation -Testable design process / product hypotheses -Evaluate
Communication	-Communication

Source: (Hevner & Chatterjee, 2010)

In support of Table 6.2, the design science research objectives for this study are articulated below:

i. Problem identification and motivation: The study identified specific research objectives that justify the implementation of FSNS in universities in Zimbabwe. The problem definition became the motivation within which the FSNS was conceived. This objective was also useful beyond our interests it became the motivating factor for the study's respondents as it helped provide the reasoning associated with our understanding of the problem. The requisite resources at this stage included the knowledge of the problem and the urgency of its solution.

ii. Objectives of a solution: This juncture provides the objectives of the much-needed solution from part (i), which is the development of the FSNS framework. The objectives followed a pragmatic philosophy encompassing both quantitative and qualitative methods to produce a desirable solution. The resources required at this stage were the knowledge of the needed solution (FSNS framework).

iii. Design and development: This stage aimed to create the artefactual solution in the form of the FSNS architecture and framework. It also determined the desired processes and links of the FSNS architecture. The resources required at this stage included knowledge of FSNS theories and existing frameworks.

iv. Demonstration: Demonstrating the existing and conceptual FSNS framework involved the use of similar case studies in both education and non-educational environments. The resources needed for this level of objective included effective knowledge of how to implement a framework to solve a particular problem.

v. Evaluation: Aimed at observing and measuring how well the FSNS framework provides a solution to the problems encountered in higher education regarding eLearning. At this stage, the study pursued an expert review to evaluate the proposed FSNS framework. The reviewers' recommendations were used to improve the framework. This required knowledge of both qualitative and quantitative analysis techniques as well as university stakeholder feedback.

vi. Communication: Scholarly research publications were produced to capture a wider audience which might have an interest in the study to communicate the research problem and the importance of the research solution or framework. Knowledge of literature review, analysis, findings discussion and conclusion was imperative at this stage.

6.4 Research Methodology

This chapter addresses methodological matters including research strategy, sampling techniques, research methods and data analysis techniques, as well as discussing data sources and validity and reliability issues. Figure 6.1 below provides a summary view of what this stage of the study describes, in line with the research onion by Saunders et al. (2016a).

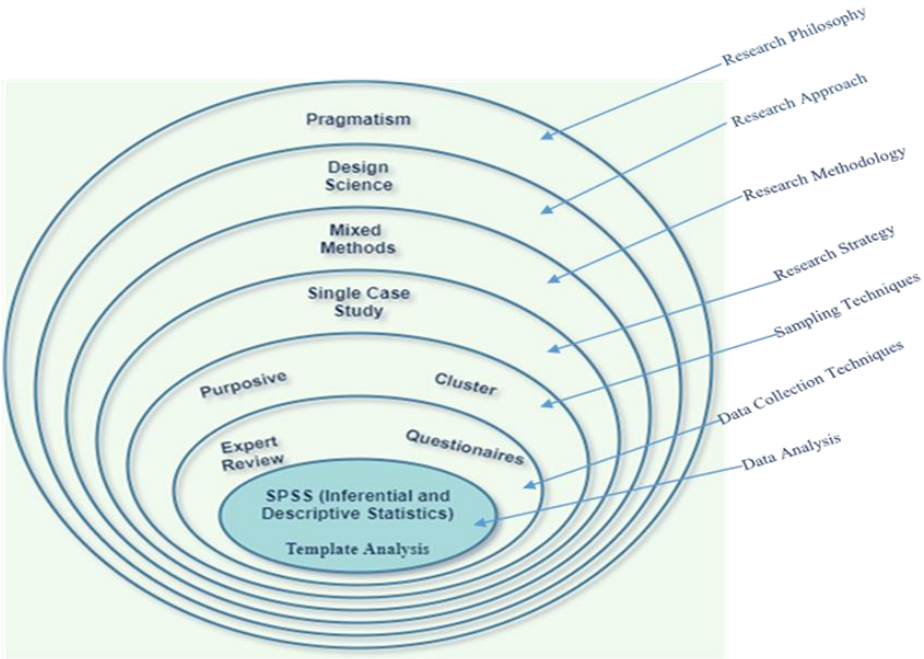


Figure 6.1: Research onion (Saunders et al., 2016)

A research methodology is a debatable phrase; in this study, it refers to methods, processes or approaches pursued in a well-planned investigation to discover a phenomenon (Long, 2014). Research methodology can be qualitative, quantitative or mixed; the choice of a methodology is influenced by a research philosophy, as identified earlier in this chapter. A qualitative research approach is concerned with quality issues stemming from views, beliefs and attitudes (Lacey and Luff, 2007). Usually, it is

aligned with the interpretivist philosophy, which values human thoughts, experiences and behaviour under a particular phenomenon.

Qualitative research employs themes, patterns or trends to analyse data, while we work on finding an insider's perspective. Accordingly, qualitative study is a non-numerical and descriptive approach that appeals to reasoning and employs selective language to describe and understand a phenomenon, while quantitative research is concretised on the positivist philosophy, which has an interest in mathematical calculations or quantity estimations. (Mässing, 2017; Caetano *et al.*, 2018). A qualitative research approach is descriptive, non-numerical, appeals to reason and employs language to understand and describe a situation (Caetano *et al.*, 2018; Farhan *et al.*, 2019).

A mixed research methodology aims at bridging the gap between qualitative and quantitative research outcomes (Downward and Mearman, 2007). Critically, it recognises the value and contribution of the two paradigms to maximise the quality of the research outcome. In line with the taxonomy of research paradigms in the information systems field instituted by (Mahlangu, 2020), mixed-method research is aligned with pragmatic research philosophy. Table 6.3 below expresses that pragmatism aligns with a mixed methodology philosophy.

Table 6. 3: Relationship between pragmatism and mixed methodology

Philosophical Element	**Pragmatism**
Ontology	Reality is multiple, external and interpreted differently depending on a phenomenon (Maarouf, 2019).
Axiology	Scientific patterns and practices are naturally theory- and value-laden (Abbasi, Hosnavi & Tabrizi, 2013).
Epistemology	Knowledge is not constant as it changes through experience and the current trend of systems, which requires a multiple approach to acquire (Maarouf, 2019).
Methodology	Mixed methods

Adopted from (Mahlangu, 2020)

With regard to the discussions above, this study adopted a mixed-method research methodology aimed at gaining an in-depth understanding of FSNS adoption by the targeted Zimbabwean university audience. The method was the best fit for this study as it gave an undiluted voice to the study and ensured that the findings were grounded on participant experiences. The research design incorporated both qualitative and quantitative forms, which were concretised in pragmatic research philosophy and the design science paradigm. In line with that, the mixed methods provided us with a rigorous approach to answering research questions on the FSNS, which is still at the developmental stage and not as favoured in a single case study of a Zimbabwean university.

6.4.1 Mixed-Method Typology

This section aims to illustrate Creswell's (2009) models of mixed-method typology. The models exhibit various relationships between qualitative and quantitative research design as they contribute to mixed-method results.

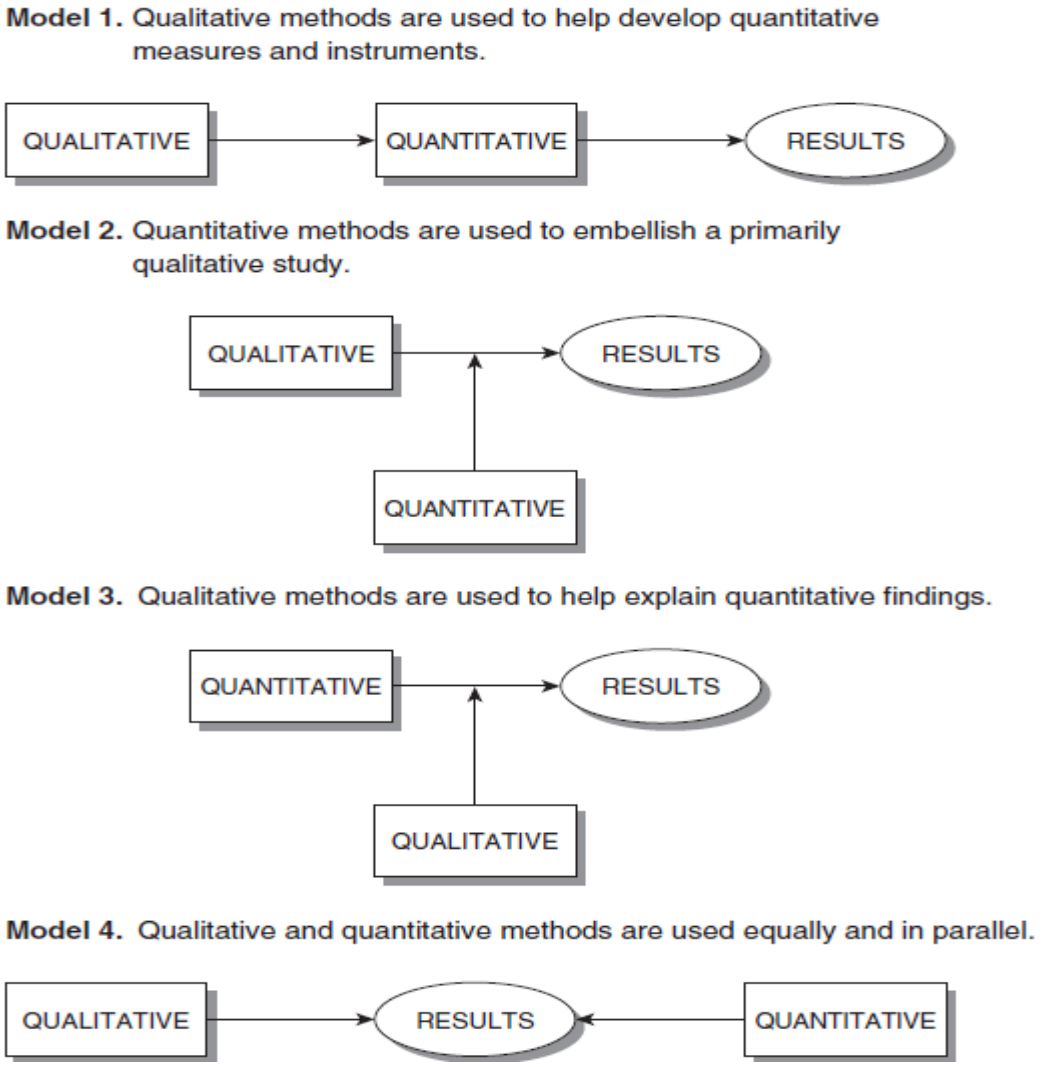


Figure 6.2: Mixed-method typology models (Creswell, 2009)

The mixed-method research typology was established to guide and assist the development of the language for mixed-methods research (Doyle, Brady & Byrne, 2009). As illustrated in Figure 6.2, this study adopted *Model 3*, in which a qualitative method is used to explain quantitative findings. Expert reviewers contributed to the qualitative analysis data towards an FSNS framework. In addition, the study pursued a stratified and sequential multi-level model for method triangulation (Mahlangu, 2020).

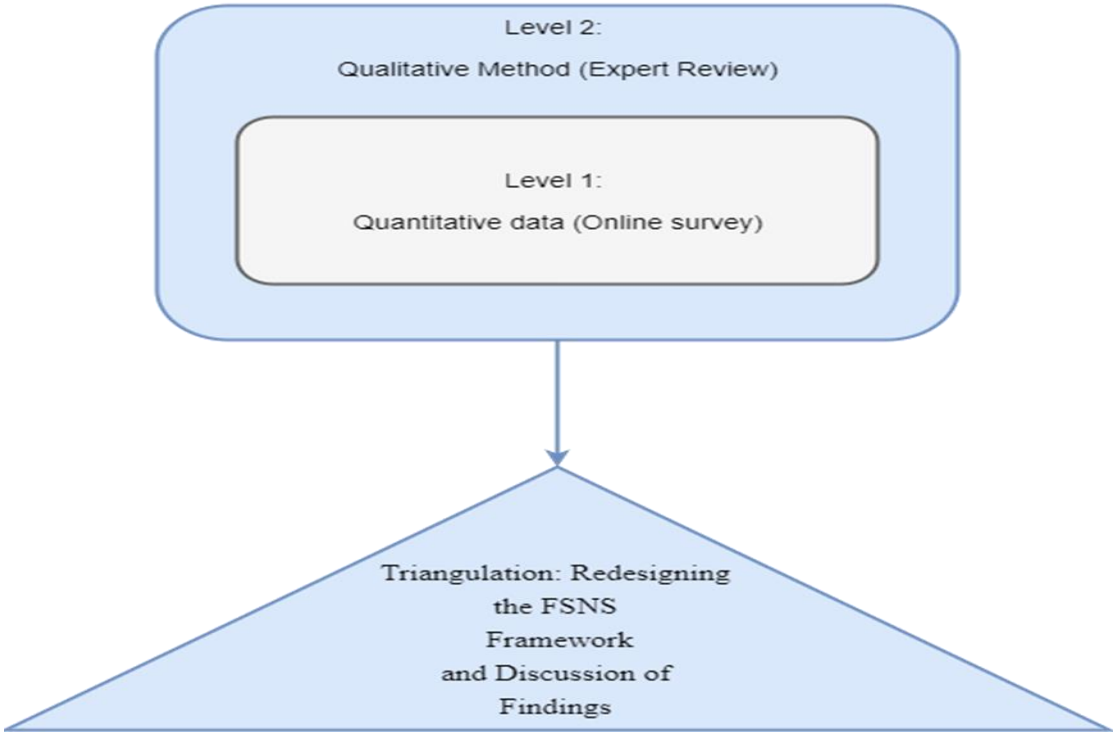


Figure 6.3:Mixed-method typology multi-level (Eastwood, Jalaludin & Kemp, 2014)

The model in figure 6.3 allowed the use of triangulation in the study. Doyle et al. (2009) assert that the traditional model of triangulation of mixed-methods design is the convergence model, in which integration occurs during the interpretation phase. This involved the procedural collection and analysis of gathered data using both quantitative (survey) and qualitative (expert review) data. Data from the quantitative and qualitative sources were gathered independently. Subsequently, the findings largely contributed to the evaluation and validation of the FSNS framework.

6.5 Research Strategy

Table 6.4 shows the relationships between research strategy, questions and their action mechanisms.

Table 6. 4 Research Strategy, Questions and Action Mechanism

Research Strategy	Research Questions	Action Mechanism

Case Study	How and What	The researcher's study is based on a particular phenomenon or research context (Burma *et al.*, 2013).
Action Research	What, Why and How	Involves active participation of the researcher to experience and observe how the outcomes unfold
Archival or Historical Analysis	Who, Why, Where, What, How many and When	Researcher analyses and investigates a particular phenomenon using historical data (Woodhill, 2012).
Experimentation	What, How, How long and Why	Involves experiments and results, tests and analysis (Oye, Salleh and Iahad, 2012).

Action research, archival analysis and experiments are some of the most prevalent research strategies. Therefore, this study pursued a case study research strategy to generate an in-depth and multifaceted understanding using a pragmatic approach to gather real-life experiences and closely examine them within the specific context of a Zimbabwean university environment. The case study attempted to illuminate a set of mechanisms regarding what has to be implemented as an FSNS framework to ensure contemporary eLearning delivery in universities. The diagram in Figure 6.4 below illustrates several case study designs and the nature of their analyses.

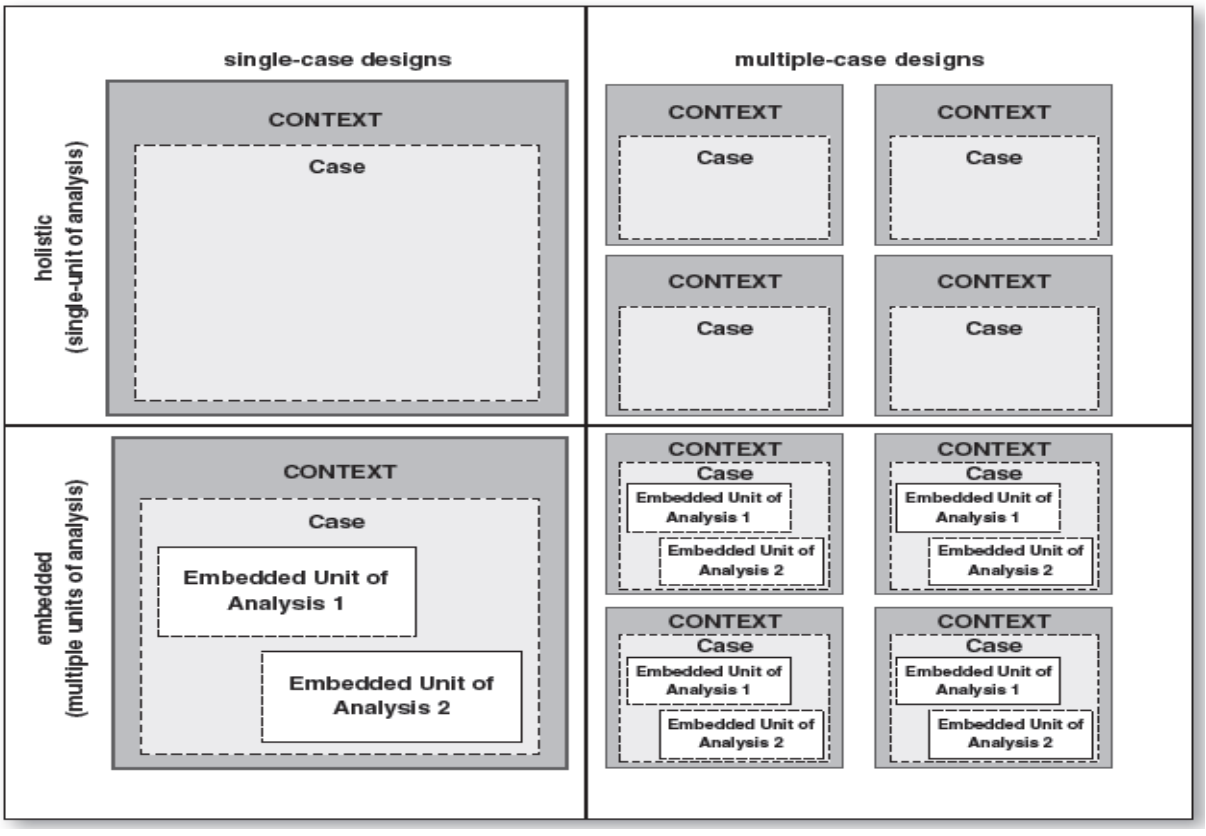


Figure 6.4: Case study strategies (Yin, 2013)

Figure 6.4 above depicts how a case research strategy can be identified as either a single or multiple case design. The designs are self-explanatory, that is, a single case is concerned with one case while a multiple case is interested with at least two or a replication of other cases. Consequently, the study adopted a single-case holistic design, which targeted one university in particular, the Midlands State University in Zimbabwe. The single holistic case study was useful as it provided a hypothesis which was tested systematically within a specific phenomenon. As such, the results shed some light on the larger context of the Zimbabwean higher education environment. Loi et al. (2015) explain that, in most cases, effective research strategies are achieved within a small geographical area. Thus, to achieve sound research outcomes, the study is specifically concerned with an eLearning framework in the higher education sector of Zimbabwe.

6.5.1 Case Study Approaches

In addition to the aforementioned case study research designs, there are fundamentally three approaches to case studies the study considered:

- Descriptive case study: Aims to describe a real-life context within which there is an intervention which apparently is taking place or has already occurred. In such a case study, there is an analysis of a sequence of interpersonal events in a given period. It seeks to counter imminent problems using different strategies. Normally, it is associated with a description of the culture or subcultures of an organisation. In that case, data is analysed as it is received or is described as it occurs which is meant to examine the depth of a problem timeously.

- Explanatory (casual case study): Implemented in an attempt to explain the causal links between real-life interventions, which may be complex experimental surveys or strategies. This approach is significant in studying organisational processes and mostly uses the ‘why’ or ‘how’ approach to explaining a real-life phenomenon and justifying the existence of certain data. Importantly, the questions are answered with little or no control by the researchers over the occurrence of events. Yin (2013) explains that this is usually applicable in multivariate complex cases, best explained by three rival theories: social interaction theory, problem-solving theory and knowledge-driven theory.

- Exploratory case study: This approach is interested in exploring situations in which there is no apparent, perceivable set of outcomes. This is more applicable in an organisational research scenario where pilot case studies are conducted to generate questions and hypotheses. Therefore, it answers questions, for instance, “does a business have the needed strategies or framework in place to solve a problem, if so, how”. In that manner, investigations and data collection procedures prior to fieldwork studies constitute an exploratory case study. This approach is taken to set up a preliminary framework before further complex investigations. Hence, it is launched, configured in the early stages of a project and justifies the feasibility of conducting further studies.

Accordingly, this study opted for an exploratory case study to formulate and develop a federated social networking site (FSNS) framework for enhancing eLearning in higher education. The study explored an eLearning phenomenon where there is a need to ensure a cross-learning/communication platform between existing social media sites. This was an attempt to answer such questions as 'what', 'how' and 'why' an FSNS framework has to be in place for quality eLearning provision and meeting the global demands of higher education. Such questions are also in line with a mixed research method, of which the objective is to bring about all views or angles of any given phenomenon.

6.6 Population and Sampling

Population in this study refers to the entire number of cases within which a sample has been drawn or a collection of people where inferences were made (Ilker, Rukayya & Sulaiman, 2015). In that regard, the population was drawn from Midlands State University, and the respondents included lecturers, administrators and students. Lecturers at universities are subject experts who design and deliver much-anticipated educational curricula using a range of methods and platforms. Students are the key stakeholders in the universities as they are the largest consumers of the provided curricula, while administrators coordinate academic programs in the university environment. Table 6.5 lists the total sample size of the study.

Table 6. 5: Sample size

Participants	**Sampling technique**	**Sample size**
Lecturers	Cluster	300
Administrators	Cluster	52
Students	Cluster	400
Expert Reviewers	Purposive (Expert sampling)	10
Total		762

The sample size of the study totalled 762 participants considering both cluster and purposive samples.

6.6.1 Purposive Sampling

Purposive sampling is a non-probability technique, in this case, the target population was selected by its relevance to the study's goals on whether or not said population matched a set of criteria for the research participation (Awa, Ukoha & Igwe, 2017). Expert reviewers for the FSNS Framework constituted the purposive sample from professional fields in Higher Education and Information Technology. Other existing non-probability sampling methods, though not considered in this study,

include snowball sampling and convenience sampling. The snowball sampling technique is pursued when the required traits or data from a target population are difficult to come by. The convenience sampling technique targets an easily accessible population; however, the population should meet certain functional conditions, such as the desire to participate, geographical proximity and availability of time (Hameed, 2016). The expert sampling technique targeted participants to illicit expert information based on subject knowledge, expertise and relationship regarding eLearning, information technology and higher education.

6.6.2 Cluster Sampling

The non-probability technique pursued in this study was cluster sampling, which is an innately quantitative technique aimed to ensure equal opportunity for participation within a given population (Taherdoost, 2018). The process divided the population into clusters (groups) as relates students' levels of education and academic departments. The lectures and administrators were also clustered according to academic departments. The clusters were further deconstructed into sub-clusters based on gender (male/female). Thereafter, a random sample from each cluster was selected, which constituted the final sample. The study's cluster sampling stages observed the following procedures (Ilker, Rukayya and Sulaiman, 2015):

- Selected a cluster (grouping) for the sample frame, such as a department
- Gave each cluster a number
- Selected a sample through random sampling

According to Zafar et al. (2015), there are two types of cluster sampling:

- Single-stage cluster sampling: Data are selected from every single unit in the selected clusters.
- Multi-stage cluster sampling: We randomly select individual units from within the constructed clustered to use as a sample.

Accordingly, the study pursued a single-stage cluster sampling with the following four (4) stages:

Stage 1: Defining the population

Figure 6.5: Determining the sample size

The cluster sampling process began by defining the population crucial for the study, as shown in Figure 6.5.

Stage 2: Dividing the sample

One of the important stages in the cluster sampling process is to ensure that each cluster's population is as diverse as possible (Gaganpreet, 2017). It also ensured that each cluster had similar characteristics to the entire population represented in each cluster; for instance, each cluster had both female and male participants. Figure 6.6 below illustrates how the sample was divided from a selected population.

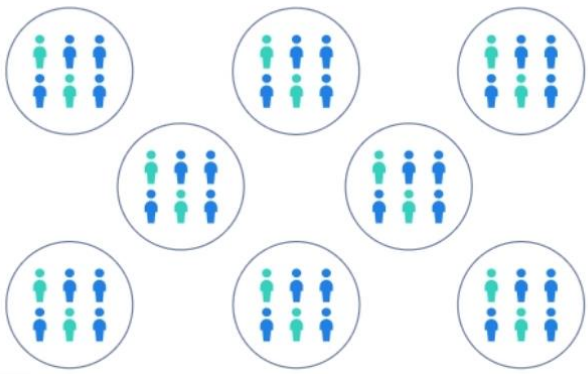


Figure 6.6: Dividing the sample

Taken together, the divided clusters represented the entire university population.

Stage 3 Random Selection

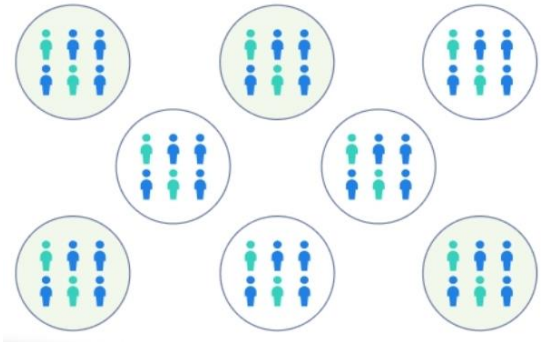


Figure 6.7: Random selection

Each cluster was assigned a number, and each cluster mini-represented the entire population. The study randomly selected clusters (shown in turquoise in Figure 6.7), which imitated simple random sampling to achieve the validity of results.

Stage 4: Data Collection from the sample

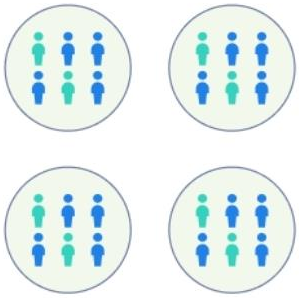


Figure 6.8: The final sample

After the random selection of clusters, data were collected from every unit, as depicted in Figure 6.8. Therefore, this became a final sample for the study.

6.6.3 Sample determination

Sample size determination is an act of choosing replicable participants to be included in the statistical sample of the size. The study followed the John Curry rule of thumb for a quantitative survey, while the concept of saturation was used for qualitative expert judgement. The process is summarised in Figure 6.9.

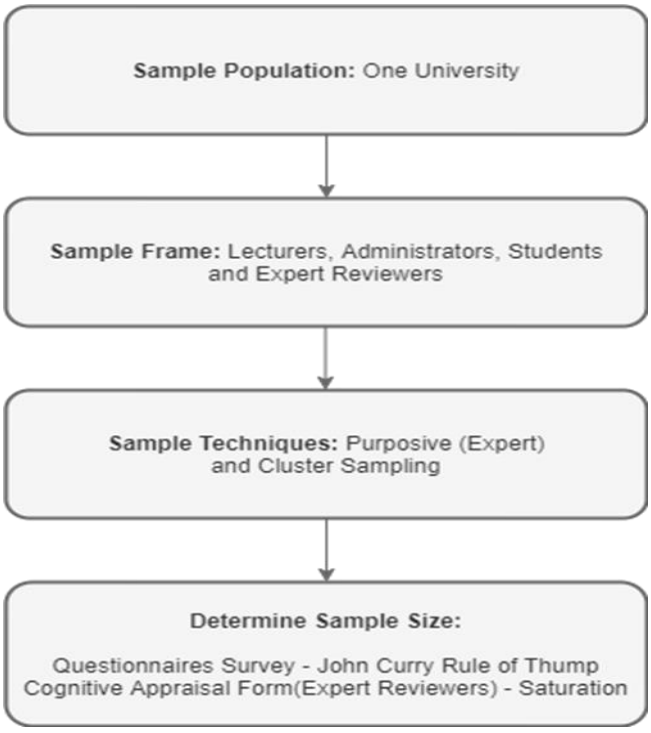


Figure 6.9: Sample determination process

6.6.3.1 John Curry's rule of thumb

Table 6. 6: John Curry's rule of thumb on sample determination Rule of Thumb	Range of Population size (N)	Sample Size as a Percentage of Population (S) (minimum)
Rule1	The larger the population size, the smaller the percentage of the population required to get a representative sample	
Rule 2	< = 100	100%
Rule 3	< = 1 000	10%
Rule 4	< = 5 000	5%
Rule 5	< = 10 000	3%
Rule 6	>10 000	1%

Source: Yirga et al. (2017)

By the time of writing, Midlands State University had about 22 000 students, 1000 Lecturers and 52 faculty administrators. Therefore, 1% of 22000 is a minimum of 220 participants, although the study had 400 students as participants. Regarding lecturers, 10% 0f 1000 is a minimum of 100 participants; thus the study selected 300 lectures, while 100% of the administrators were selected as they totalled only 52, in line with John Curry's rule of thumb in table 6.6.

6.6.3.2 Saturation for Expert Review

Saturation is a technique used in qualitative methodology in which the sample size is determined by the following aspects (Marshall et al., 2013):

- A point in time when the qualitative data obtained from expert reviewers no longer significantly change the coding manual.
- A point when recently attained data from the expert reviewers become repetitively the same as the previous data.
- A point at which the performance of the research tool declines, for instance, in this case, when expert reviewers contributed less than the previous participants.

Ultimately, 10 expert reviewers contributed to the study based on the aspects raised above.

6.7 Data Gathering Techniques

In line with the mixed methods research design, the study aimed to systematically collect, analyse and integrate quantitative and qualitative data, which contributed to the federated social networking framework development. The process was achieved through the adoption of a questionnaire survey (quantitative) and expert reviews (qualitative).

6.7.1 Online Questionnaire Survey

A quantitative online questionnaire survey on *Google Forms* was administered to gather data from a pool of respondents using an online email tool (see Appendices 1–3). A questionnaire is the main way of collecting primary quantitative data and can contain closed-ended and open-ended questions. For this research, the questionnaires contained closed-ended questions to allow for the collection of quantitative data, and open-ended questions to allow the experts to give their opinions openly. As previously discussed, the number of people who participated was determined using John Curry's rule of thumb. A total of 400 students, 300 lecturers and 52 administrators participated in the closed-ended online questionnaire survey (Kisanga, 2016; Saunders, Lewis and Thornhill, 2016; Kivunja and Kuyini, 2017; Yirga, 2017).

The method involved numerous respondents who were asked a total of 24 questions; it was used to gather information related to new features and trends on social networking sites. Thus, it was in line with this study's objective to gather information that was used to develop somewhat new features for the FSNS framework. At the same time, the method provided readily available information about the necessary mainstream framework issues. The present study used *Google Forms*, which the study considered an easy online application while, at the same time, achieving robust output. This online survey tool was provided in unlimited free form, and the results were sharable and mobile friendly, with customisation of the questions and the provision of timeous reports. In addition to flexibility, the online surveys provided much-needed anonymity, which was ideal for the study's respondents. The following steps were considered in guiding a successful survey (Mavridis *et al.*, 2012):

- Articulating the survey objective: Provide a clear picture of the goals of the research
- Creating a list of questions: Decide on the nature of the questions which meet research objectives
- Online invitation of respondents and distribution of questions: Decisions on how to disseminate the questions to the selected respondents
- Gathering responses: Convince the respondents to participate
- Analysis of results: Present the data through tables and use inferential statistical analysis.

6.7.1.1 Questionnaire Content Validation

At this stage, the potential effectiveness of the questionnaires is determined. The questionnaires should form a cohesive, smooth flow of questions that are asked in a logical order (Nina, Adantios & Bodo, 1993). The questionnaires were sent to 10 PhD holders considered experts in the fields of computers, information systems and education and the following were noted and clarified:

1. The scale of the age ranges was too broad, and there was a suggestion to reduce the range and further, that there should not be a closed loop on the age ranges. Consequently, the range started

from 22 or less instead of stating a range of 18–22 or 25–30 years, going upwards. In addition, the highest age was 61 and above instead of a cut-off of 60 for students. For lecturers and administrators, the range was amended to 30 or less as the starting range and 71 and above as the top end.

2. The grid table had no neutral option, obliging all participants to choose an option, even if they did not want to choose an option on that row—thus, the option was added.

3. Instructions such as "check one oval only" and "check all that apply" were also added.

6.7.2 Expert Review

Expert review (see Appendix 5) is one of the best techniques for assessing frameworks and models used in design evaluation. In that regard, experts should possess specific characteristics pertinent to the research topic. The technique involved 10 experts with at least five years of working in the academic and IT fields, who independently analysed the research through the FSNS framework to identify problems and provided corrective recommendations. For qualitative recommendations on the study's federated social networking framework (FSNS), the expert analysis or heuristic review was pursued by targeting IT professionals in the social media domain as well as educators with the same interests (Taherdoost, 2018). There are several approaches to expert reviews: which includes:

- Rapid Reviews: Provides a rapid synthesis of knowledge on emergent policy or attempts to inform an evidence-based decision as soon as possible.
- Realist Review: Aims to explain a social phenomenon which seeks to answer questions on 'what' and 'how' within a societal setting.
- Scoping review: Maps the body of literature and identifies key concepts of deficits in previous research.
- Integrative expert review: Aims to critique and synthesise several study designs. Its purpose is to generate new experimental/non-experimental/theoretical frameworks.

Consequently, the study pursued an integrative expert review which systematically contributed to the generating of a new framework. In contrast with user-centred methods, for instance, the usability test, the expert-based research methods involved multiple roleplayers who independently analysed the FSNS and its usability in a higher education environment. The expert review template was used to collect expert opinions and observations. Table 6.7 contains a sample of the expert review template.

Table 6. 7: Sample Expert Review Template

FSNS Framework Quality	Comments
Usefulness of the FSNS Framework	
Relevance of the FSNS Framework	
Usability of the FSNS Framework	
Completeness of the FSNS Framework	

Systematic construction of the FSNS Framework	
Strength of the FSNS Framework	
Weakness of the FSNS Framework	
Is there anything missing in the FSNS framework that might need to be added? If yes, please indicate and justify.	
Is there anything in the FSNS framework that might need to be removed? If yes, please indicate and justify.	

The template was utilised to assess the proposed FSNS framework's relevance, understandability, usability and completeness, among others. Ultimately, the recommendations were used to alter the proposed framework, which resulted in several changes to the framework. To that end, expert opinion helped identify major issues and the possibility for improvement.

6.8 Data Analysis

Data analysis is the procedure of reducing collected data, which can be quantitative or qualitative, to develop patterns, summaries and controllable scope and apply the most appropriate data analysis techniques which help to answer the research objectives of the study. The process involves merging data and comparing sets of data outcomes and what it means to the study. Depending on the trajectory of the study, data analysis is largely predicated on the data collection tools employed in the study. This study employed a mixed research methodology; the process comprised analysing both the qualitative and quantitative data (Lacey and Luff, 2007; Palinkas *et al.*, 2015).

6.8.1 Quantitative Data Analysis

Different statistical tools and techniques can be applied to analyse quantitative data. The quantitative data gathered in this study were analysed statistically using the *Statistical Package for Social Sciences* (*SPSS*) version 20.0. *SPSS* is one of the most powerful and common statistical analysis tools (Skuza and Gregory, 2013). The quantitative analysis process commenced by coding and exporting the data collected through *Google Forms* to the *SPSS* platform. The study employed two quantitative data analysis procedures, i.e., descriptive and inferential statistics. First, the descriptive statistics presented a summary of the quantitative findings in bar charts, graphs and tables. For instance, the distribution of participants by gender, designation/status and qualifications were presented in the tables. Second, inferential statistics were used to infer the properties of underlining data probability distributions. The study adopted the following statistical methods by Hung (2006):

- Testing for normality: To determine if the dataset of the study is well-modelled by a normal distribution, thereby informing on which statistical tools to use.

- Reliability test: To ascertain the reliability of the questionnaire (survey instrument)
- Correlation test: To determine the relationships between some demographic variables and social networking sites subscription.
- Hypothesis test: To check if some demographic variables affect the social networking site subscription in universities.

The usage of both descriptive and inferential statistics for this study is presented in table 6.8 below.

Table 6. 8: Taxonomy for analysing quantitative data in this study

Level of Analysis	Items of Analysis	Analysis Procedure
Level 1	Data preparation: reliability testing, data cleaning, screening and coding	Descriptive Statistics
Level 2	Description of the respondents: profiles of gender, age, marital status, level of education and internet using frequency tables	Descriptive Statistics and Inferential statistics
Level 3	To study SNSs used by colleges	Descriptive Statistics
Level 4	To look for the similarities and differences between types of SNSs	Descriptive Statistics
Level 5	To analyse the benefits of using FSNSs as an eLearning tool.	Descriptive Statistics
Level 6	Conduct theoretical modelling using factor analysis and mean determination.	Descriptive and Inferential Statistics

6.8.1.1 Justification for a Quantitatively Skewed Mixed Method

The following aspects justify the need for more a quantitatively skewed mixed-method study, which is in line with Apuke (2017) and Fischer, Boone and Neumann (2014).

- The quantitative method predominantly contributed to a more scientific outcome since the study generated a large quantity of data (752 participants), which needed to be managed and analysed by the statistical tool to reduce the margin of error in the results. A larger sample of participants could have been very difficult to handle using a qualitative research approach.

- The method provided less biased, objective analysis since the study aimed to observe high objectivity in answering research questions.
- For the timeous production of results, quantitative data-gathering is proven faster than qualitative data collection; the latter suffers from poor responses from participants due to a lack of time to answer structured questions. In addition, quantitative data analysis is less time-consuming as a need to put data into themes is less likely.
- A quantitative presentation allows for a simpler arrangement and interpretation of the data. Furthermore, the data can be easily interpreted through tables and graphs, hence can be readily used for decision-making.
- Quantitative research outcomes are highly generalisable and can be used to predict future performance, for instance, a framework or strategy within an organisation or other business variables, and can further be used to investigate various causal relationships currently prevailing in a phenomenon.
- Lastly, the research chose more quantitative aspects due to their focused nature. These were based on a theoretical framework; thus, the study attempted to test existing theories and ultimately, rejected or supported them using hypotheses while seeking facts and evidence.

6.8.2 Qualitative Analysis

Qualitative data analysis is achieved by arranging data by coding it into themes and patterns. These coded texts are categorised as patterns or themes, which can then be transformed into findings and related to existing theories or literature. The purpose of coding text is to ensure that the study generates the main ideas relevant to the study. There are five (5) data qualitative data analysis approaches: pattern matching and explanation, data display and analysis, template analysis, narrative analysis, discourse analysis and grounded theory. Of all the five qualitative approaches listed above, only pattern matching and explanation is a deductive qualitative approach, while the remaining four are inductive approaches (Saunders, Lewis and Thornhill, 2016; Nassaji, 2020). Therefore, this study employed a template analysis approach in determining the expert reviewers' responses, as discussed in Section 6.8.2.

6.8.2.1 Assumption Underpinning the Template Analysis Process

The following assumptions underpinned the use of a template analysis technique in this study (King and Brooks, 2018):

- Due to its flexibility, template analysis is not entirely tied to a single epistemology; instead, it can be used in studies grounded in various epistemological positions and, therefore, can be adapted to the requirements of a specific study.
- Template analysis does not rigidly prescribe data analysis procedure; hence it is continuously revised and refined for it to meet the needs of a study.

- The process takes note of both divergent and convergent views and tries to establish a causal relationship among those differing views.

- Template analysis can be employed to investigate different perspectives on a phenomenon.

6.8.2.2 Analysing Expert Feedback and Suggestions

The expert-reviewed data was analysed qualitatively guided by the five quality parameters for validating the FSNS framework, which include relevancy, completeness, usefulness, usability, weakness and strength. The responses were grouped by quality parameters, using the validation template to collect the experts' comments and evaluations. The suggestions by the expert reviewers were analysed through abductive and retroductive approaches (Downward and Mearman, 2007). In this study, abduction involved analysing data falling outside the expected FSNS framework, while retroduction involved the researcher's conceptualising circumstances without which the FSNS concepts could not exist. Therefore, the processes were achieved by moving back and forth between the data and the existing research knowledge body, verifying if the suggested construct was supported by the literature.

6.8.3 A Multi-level Unification of Methods

Data were collected and analysed using both quantitative and qualitative methods. The multi-level model was accomplished by gathering data through web-based questionnaire surveys and expert reviews. The study started by performing statistical analysis to reveal correlations within the constructs of social networking sites and their usability in a higher education environment. Nevertheless, statistical analyses were not adequate for devising the proposed FSNS framework. Thus, a qualitative method (expert review) became necessary to complement statistical analysis by enhancing an in-depth study on context-specific federated social networking sites.

The multi-level unification procedure intends to validate findings from different viewpoints, especially where different data collection methods were used. Similarly, the underlying assumptions about methodological unification in pragmatism are meant to capture a unified reality from different methods. Conventionally, methodological unification is an important assignment in a research strategy underpinned by pragmatism. It is noteworthy to mention that multiple methods possibly provide complementary insight into the same phenomenon. The process involves converging and confirming research findings from case study surveys and expert reviews as diverse methods utilised to investigate a single phenomenon. Thus, methodological unification is regarded as a hallmark of pragmatism (Downward and Mearman, 2007; Modell, 2009; Eastwood, Jalaludin and Kemp, 2014).

6.8.4 Quality Checks of Mixed-Methodology Research

This subsection deliberately presents the quality checks of multi-methodology research, although quality checks should be situated during the epistemological stage at the beginning of the methodology chapter due to its close link to knowledge claims. The study took this dimension because it attempted to evaluate the quality and end of the methodological aspects of the study. In addition, the attributes

employed to evaluate the quality of findings vary according to the type of data and research. For instance, quality checks such as reliability, validity and generalisability are preferable in evaluating quantitative data, while credibility, confirmability, dependability and transferability are usually used in scoping the validity checks of qualitative data (Heale & Twycross, 2018; Kyngäs, Kääriäinen & Elo, 2020; Willig, 2021).

6.8.5 Trustworthiness Parameters of the Study

The study was guided by a set of principles to achieve the trustworthiness of the study, as described in Table 6.9.

Table 6. 9 Guiding principles of trustworthiness of the study

Quality attribute	Description	References
Conformity	Showing that findings or interpretations are directly inferred from the data. Schemes employed to limit biases and ascertain that the data the information provided by participants.	(Nowell *et al.*, 2017)
Objectivity	The study should reflect the phenomenon being studied rather than the opinion of the researcher.	(Hollweck *et al.*, 2019)
Reliability	The degree to which different studies in the same context can produce similar findings on the object of enquiry.	(Hollweck *et al.*, 2019)
Dependability	Denotes the consistency of data over time and under different environments.	(Elo *et al.*, 2014)
Validity	In qualitative findings, refers to the preciseness of data presentation and interpretation.	(O'Leary-Kelly and Vokurka, 1998)
Credibility	The extent to which the findings correspond to the truthful meaning from the narration of the respondents.	(Rubin, 2020)
Transferability	The degree to which the findings of the study are useful in similar contexts.	(Elo *et al.*, 2014)

Based on the guiding principles in Table 6.9, Table 6.10 elaborates on measures taken to achieve the much-needed trustworthiness of the study.

Table 6. 10: Measures undertaken to achieve trustworthiness of the study

Quality attribute	Strategy	Action Taken
Validity (transferability and validity)	Data collected should reflect what participants experience (Fletcher, 2017).	Probing questions were used to encourage respondents to give undiluted opinions.
	Data collection procedure should attempt to modify the participants' original perceptual experiences and thoughts.	We sent back analysis templates to expert reviewers to confirm their responses.
	There is a general perception that PhD students are a fountain of knowledge, resulting in a power	Showing humility in all communication processes, reassuring respondents of the

	discrepancy between the researcher and participants. Hence, the power discrepancy between the researcher and participants should be minimised at all costs (Morrow, 2005).	importance of their contributions to the success of the study.
	The research should present facts accurately, as perceived by the participants (Elo *et al.*, 2014).	We presented the responses accurately from the expert reviewers, even responses that challenged our views.
Reliability (Dependability)	Data collection method should present uniform questions (Hollweck *et al.*, 2019).	The same qualitative template was presented to all expert reviewers.
	The context in which data is collected should be constant for a specific period (Eastwood, Jalaludin and Kemp, 2014).	Data was gathered over a period of four months; the study assumed the phenomenon remained stable during this period.
	Usage of supportive or overlapping research methods (Fletcher, 2017).	Both quantitative and qualitative research methods were used to complement the research outcomes, that is, a questionnaire survey and expert review, respectively.
Objectivity	Data should be analysed by different independent researchers (Zarei and Mohammadi, 2021).	The proposed FSNS framework was first analysed by a group of independent expert reviewers.
	Findings should provide a mutual confirmation (Loeb *et al.*, 2017).	We used mixed methods, and the study was supported by various literature reviews.

6.9 Ethical Considerations

Ethics in scientific investigation refers to moral principles in conducting research. In that manner, researchers are expected to make a sincere effort to ensure that they adhere to the general principles of the research community. In addition, researchers must not pursue the truth while violating the rights of the participants. Before conducting the study, we obtained approval from the Registrar of the Midlands State University (Saunders, Lewis and Thornhill, 2012, 2016). We also sought ethical clearance from the University of South Africa (UNISA) Ethics Review Committee (ERC).

- Informed consent: Respondents to the online questionnaire were informed about the purpose of the study, how data would be gathered and later presented. In addition, the participants were given the chance to withdraw from the research process at any time. They were also informed of their right to refuse to answer any questions they considered sensitive or were uncomfortable with and that participation in the study was voluntary for the participants (Henderson, Hutton & McNeilly, 2012).
- Confidentiality, Privacy and Anonymity: Research ethics require researchers to treat all data with confidentiality, privacy and anonymity. We ensured that participants' names and positions at the university were protected in gathering data, in line with privacy, social security and confidentiality principles. Thus, anonymity was ensured by designing a questionnaire without disclosing the people's and organisations' names (Burma *et al.*, 2013; Saunders, Lewis and Thornhill, 2016).

6.10 Summary

Chapter 6 presented the research philosophy within which the study was concretised. Hence, the research followed a design science approach with mixed methods grounded in the pragmatic research philosophy. A single case study was pursued, targeting one university. The study selected participants using both qualitative and quantitative data collection techniques: purposive sampling and cluster sampling, respectively. Purposive sampling targeted expert reviewers for the FSNS4L framework, while cluster sampling focused on lecturers, students and administrators at the university under study. Template analysis analysed the data gathered from expert reviewers. The study conducted both inferential and descriptive statistical analysis on the quantitative data gathered from administrators, lecturers and students. Thus, the study put forth the required effort to follow the research ethics regarding informed consent, confidentiality, privacy and anonymity.

The preceding chapters describe the procedures undertaken to fulfil the first step towards achieving SRO4: *To evaluate and validate the proposed conceptual FSNS4eL and then deliver an improved version for further adoption*. The subsequent chapter will expound on data gathering and presentation. The chapter presents data from three different clusters, namely students, lecturers and administrators, culminating in the expert review and a discussion of the results obtained from all respondents.

Chapter 7 : Analysis and Results

7.1 Introduction

The preceding chapter presented the research methodology and philosophy applied in this study to guide and support how empirical data were collected and the interpretation of the empirical research. The presentation and interpretation of collected data depend on the choice of a well-structured research methodology. This chapter focuses the on the presentation and interpretation of the results of the qualitative research conducted at the MSU institution incorporating the lecturers, students and administrators. The working research objective in this chapter is: *To evaluate and validate the proposed conceptual FSNS4eL and then deliver an improved version for further adoption*. The objective continues from the preceding chapter, where the first step into achieving the objective was introduced. Therefore, this is the second step towards achieving the same objective.

Chapter 7 presents the respondents' demographic data, the response rate and the bar graphs representing most of the questions in the administered questionnaires on sections of (i) SNS types, usages and benefits; (ii) similarities and differences between the social networking platforms and; (iii) how FSNSs can be used as an eLearning tool for each group, that is, lecturers, students and administrators. Sections 7.2 and 7.3 of the study scrutinise the data on the students and lecturers, respectively, and execute some statistical analysis. Furthermore, the chapter describes testing the data for analysis suitability and hypothesis testing, determining the correlation of variables and conducting factor analysis. Section 7.4 examines the administrators' data and furnishes all the statistical analyses of the students' and lecturers' data, except for the factor analyses. This chapter also presents the descriptive and inferential statistical data analysis methods. Lastly, the results from factor analysis were combined to generate a diagrammatical representation of components from the combined factor analysis of the characteristics, features and uses of the student and lecturer data. This chapter partly answers the question: *How can federated SNSs be validated and improved to attain an improved version that can be used as an eLearning tool in universities?* The next chapter continues to address the demands of the question comprehensively.

7.2 Student Data

The students would utilise the FSNS platform by accessing learning materials uploaded by their instructors and colleagues and receiving messages from administrators. Moreover, students would be expected to upload learning material to share with peers, download material from their colleagues and lecturers, upload assessment work, collaborate with their colleagues and, also view notices from administrators and respond when needed (Kuimova, Kiyanitsyna and Truntyagin, 2016; Abed, 2019; Dhawan, 2020).

7.2.1 Demographic Data Presentation of Student Respondents and Student Response Rate

This section presents the age, gender, marital status, degree status and field of study to obtain general knowledge about the student participating in the study. The response rate enabled the study to ascertain if the sample size was sufficiently representative of the population.

7.2.1.1 Demographic Data Presentation of Student Participants

The students' demographic data were categorised to enable the study to determine their usage of SNSs according to their age groups and whether the students' ages affect their utilisation of SNSs in their studies. Students' fields of study also affect their use of social networking sites, hence the necessity to understand the students' distribution, their departments and how they respond to using SNSs.

These can further be appraised by hypothesis testing where:

Age **H_0**: Student's age has no effect on SNS subscription.

Area of Study **H_0**: Student's area of study has no effect on SNS subscription.

Gender **H_0**: Student's gender has no effect on SNS subscription.

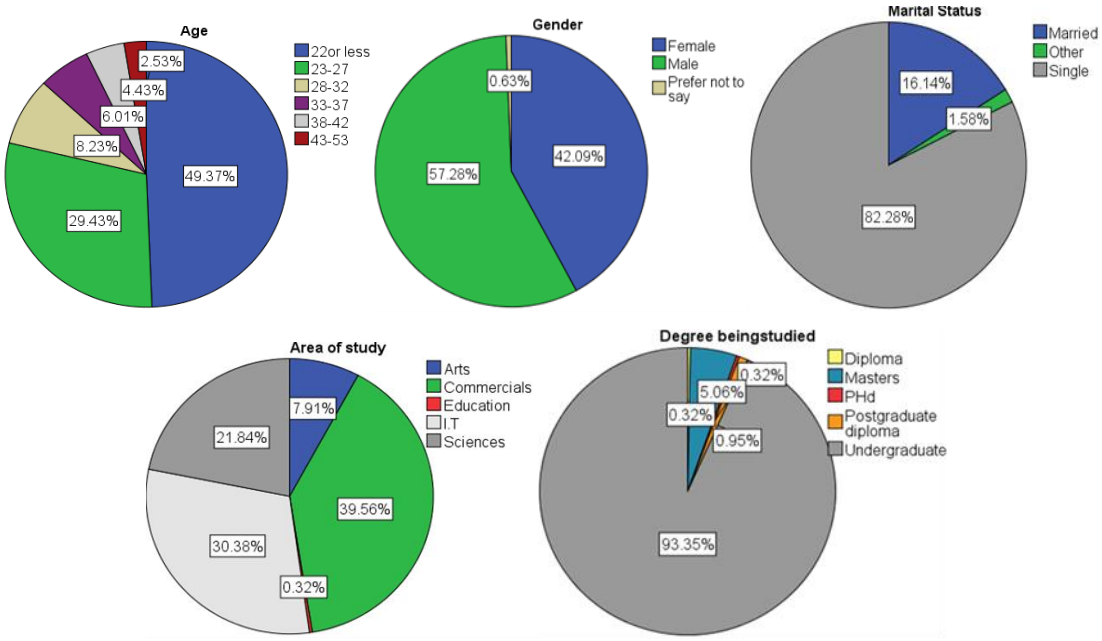


Figure 7.1: Demographics (age, gender, marital status, degree being studied and area of study)

Figure 7.1 discloses that most of the students were aged below 22 years old (49.4%) while 29.4% were 23–27, 8.2% were 28–32, (6%) were 33–37, (4.4%) were 38 to 42, and the last group (2.5%) were 43 years old or more. These results reveal that the majority of students entered university directly from high school, whereas the minority delayed tertiary education for different reasons; furthermore, most of the students (82.3%) were still single, while 16.1% were married and 'other' 1.6%, respectively. The demographical data showed that female students represented 42.1% of the respondents, and male students accounted for 57.3%. The deduction is that higher and tertiary educational institutions are dominated by male students, whereas female students are usually affected by early marriages, among others (Bengesai, Amusa & Makonye, 2021; Dzimiri, Chikunda & Ingwani, 2017; Efevbera & Bhabha, 2020). Figure 6.1 details that the majority of the respondents are from *Commercials* (39.6%), followed by *IT* (30.4%); most of these respondents were studying for their first degrees, which is reflected in the results whereby more than half (almost all the students) of the respondents were undergraduates (93.4%), followed by Masters' students (5.2%) and doctoral students. The demographics of postgraduate diploma and diploma students could not score at least one per cent each. This signifies that most students were undertaking undergraduate studies and only a few were devoted to postgraduate studies, which might indicate that some students could not finance postgraduate study or be sponsored by their companies to study abroad, or worse, failed to continue with their studies.

7.2.1.2 Response Rate

We sent 400 questionnaires to the students, of which 316 were returned, which is a response rate of 79%. (Mahlangu, 2020) supports that such a response rate is good and therefore, the validity of data for this study were not compromised because validity depends on response rate. Using the formula in figure 7.2 by Nooshinfard et al. (2012), the response rate was:

calculated as: (316/ (400-0)) *100% to get 79%

$$\frac{\text{Number of usable responses}}{\text{Total sample- Unsuitable /uncontactable units}} * 100\%$$

Figure 7.2: Response rate

7.2.2 Social Networking Site Types, Usages and Benefits

The study also wanted to determine the respondents' SNSs usage in terms of the types of SNSs used, as well as to gain knowledge on the benefits they deem as being gained from the use of these SNSs. The benefits presented in the questionnaires were taken from the literature (Buchegger and Datta, 2009; Pempek, Yermolayeva and Calvert, 2009; Kaplan and Haenlein, 2010; Eke, Omekwu and Odoh, 2014; Dlamini, Ncube and Muchemwa, 2015).

7.2.2.1 Social Networking Site Usage.

Determining SNS usage was undertaken to gain knowledge on the number of SNSs subscribers from the sample that responded to our questionnaires since our main objective was to develop an FSNS which required users of SNSs to participate.

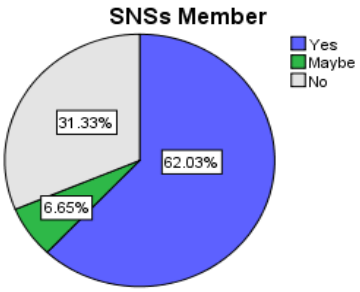


Figure 7.3: SNSs membership

In Figure 7.3 above, 62% of the respondents indicated they used SNSs, while 31.3 % claimed that they did not use SNSs, and 7.6 % were neutral. The results were good regarding the necessity of obtaining responses from those who used the SNSs, whereas respondents who indicated they were neutral scored the highest number, with a percentage of 68.6 when combined. The study wanted to uncover the benefits of using the SNSs from the primary data source since the benefits were also stated in the literature reviewed in Chapters 2 and 3. Ascertaining the types of SNSs used by the respondents was essential to the development of the FSNS intended to be used by the same respondents and their colleagues.

From those who responded Yes and Maybe to whether they were subscribers to SNSs, an analysis of the numbers of those who used specific SNSs was done. Figures 7.4 and 7.5 below display the number of respondents subscribed to each SNSs to determine the popular SNSs among university students. WhatsApp was indicated as the top SNS site (215, 17.3%); the second most popular was Facebook, with 205 (15.6%) respondents indicating that they were subscribed to it; YouTube at (166, 12.6%), Instagram at (143, 10.9%) and Twitter (122, 9.3%) were the top five popular SNSs. These results agree with Dixon (2022), who indicates that Facebook, YouTube, WhatsApp, Instagram and WeChat are the top most visited SNSs by 15 July 2022; furthermore, Id et al. (2020) and Tarisayi (2021) report that WhatsApp is the most often used platform due to its low data costs. At least nine respondents were subscribed to all the SNSs listed, as indicated by the results in Figure 7.4 below, meaning that although some of the SNSs are not popular, some students aspire to try out all the SNSs they have come across to experience the platform and to enjoy whatever advantages each SNS has to offer.[6]

Respondents who use a particular SNSs

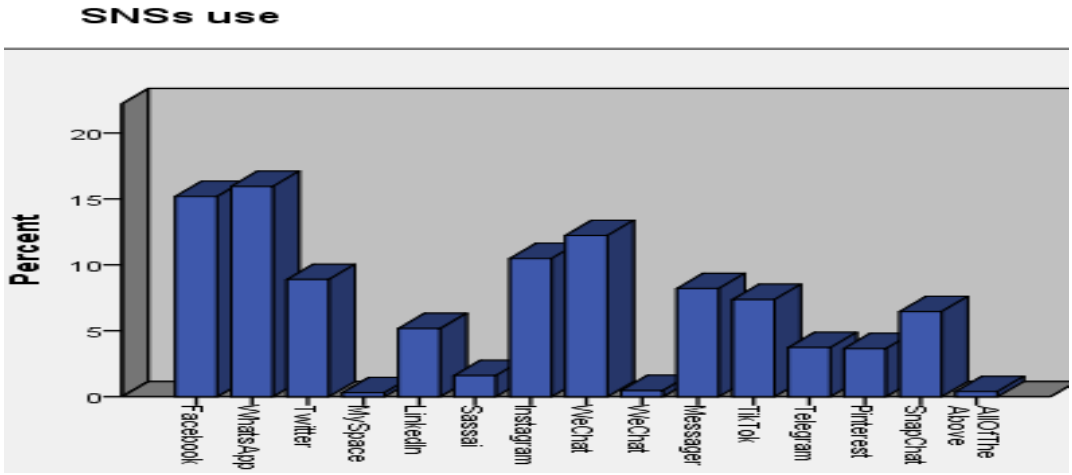


Figure 7.4: SNSs subscribers

7.2.2.2 Number of SNSs Subscribed to by Members

The survey also assessed the number of SNSs subscribed to by each respondent (see Figure 7.5), given that such subscriptions are a prerequisite for federated eLearning participation. This provided the study with an overview of the number of SNSs to be included in the federated networking sites. Although the highest number of SNSs subscribed to by our respondents was 15, with five respondents; most respondents (31) had accounts with eight different SNSs, followed by 29 respondents subscribed to five different SNSs, 28 respondents were subscribed to seven SNSs, while two members indicated they were subscribed to 12 accounts.

[6] The figures given in the description of the results include the 15 who indicated they used all SNSs

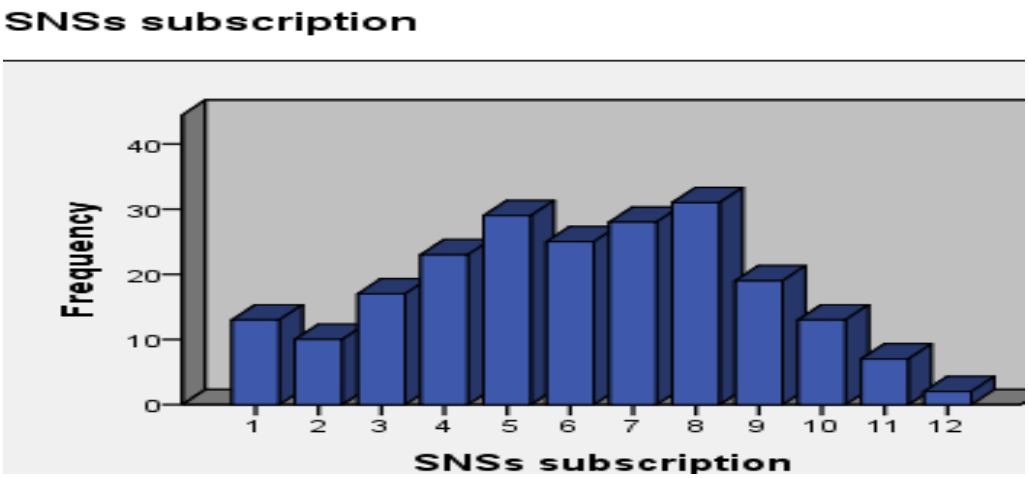


Figure 7.5: SNSs subscribed to by each student

7.2.2.3 Frequency of SNS Use

The study sought to analyse the usage patterns of the students. This information was important to the research since the SNSs should be integral to their daily activities for them to embrace the FSNS tool.

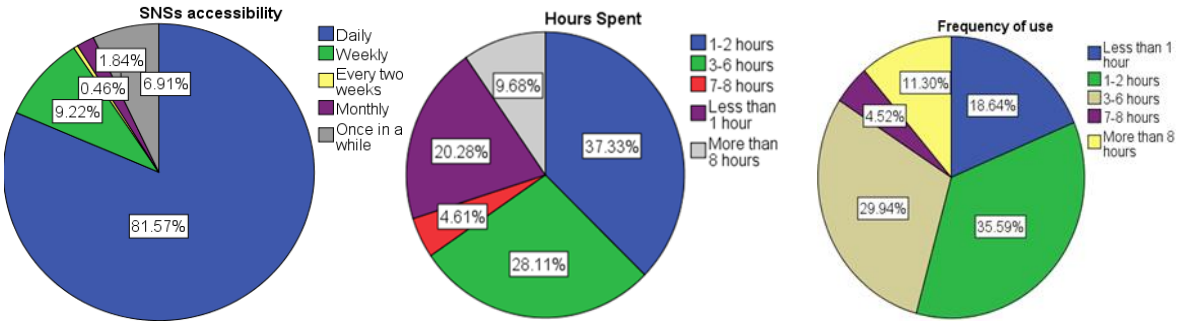


Figure 7.6: Frequency of use and hours spent

Figure 7.6 above shows that the SNSs have become part of the student's daily activities, with 81.6% of the respondents using SNSs daily and 81.4 % using SNSs daily spent at least an hour. Six point nine per cent (6.9%) of respondents indicated they visited SNSs occasionally, while 20.3% indicated they used it for less than an hour per day.

The study further analysed the frequency of respondents who visit the SNSs daily (see frequency of use in Figure 7.6 above) and discovered that the highest percentage (35.6%) accessed SNSs for only one to two hours and the lowest percentage (4.5%) said they used it for seven to eight hours. Surprisingly, those who used SNSs for more than eight hours were well represented, with 11.3% spending more than a quarter of the day on social networking sites.

7.2.2.4 Internet access

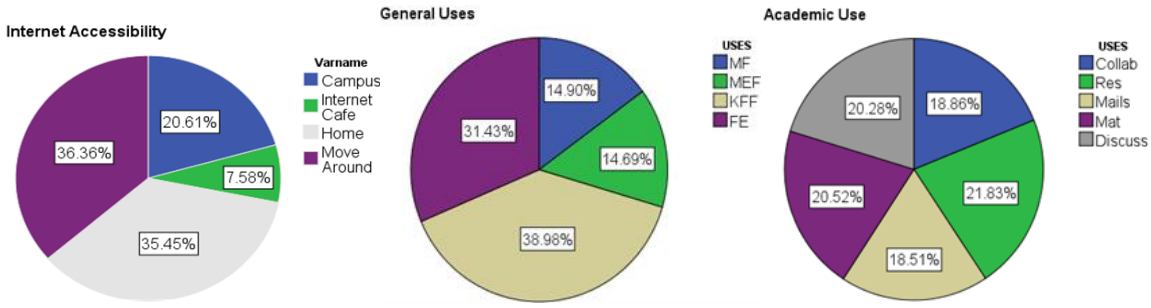


Figure 7.7: Internet accessibility, general uses and academic uses

Since most of the respondents had embraced the use of the internet, in figure 7.7 the highest number (36.4%) of respondents indicated that they moved around with their internet, the second highest (35.5%) stated they accessed the internet at home, while 20.5% indicated they accessed the internet on campus and only 7.6% visited internet cafés to access the internet.

7.2.2.5 Reasons why University Students use SNS

At this stage of the study, we wanted to learn the reasons for SNS use from the respondents, and although there were many, Figure 7.7 shows the main reasons, namely general and academic reasons for using SNSs. With general reasons for using SNSs, most (191, 39%) of the respondents indicated that they needed to stay in touch with their families and friends (KFF), followed by fun and entertainment (FE) (154,31.4%) and making new friends (MF) and maintaining existing friends (MEF) scored 73 (15%) and 72 (14.7%) respectively. Academic reasons and research (RES) scored the highest number (184, 21.8%) of votes, although the results revealed that all the given reasons, i.e., receiving and sharing materials (MAT) (173,20.5%), discussion space (DISCUSS) (171,20.3%), collaboration (COLLAB) (159,18.9%), and sending and receiving emails (MAILS) (156,18.5%), in order of the most voted for, were equally important.

7.2.2.6 SNSs Used for Academic Purposes

As seen in Figure 7.8, WhatsApp was rated as the number one platform used by students for academic purposes, largely because communication on WhatsApp students was low-cost and allowed communication with friends and relatives on the same data bundle per month (Bowles, Larreguy and Liu, 2020; Tarisayi, 2021). Indeed, the WhatsApp platform is accepted as a basic form of communication that is affordable, even compared to telephone calls. Two hundred and nine (37.6%) students voted for WhatsApp as one of the platforms they used for academic purposes, followed by YouTube with 93 (17.7%) votes and Facebook with 87 (15.6%). Of these students, 10 (1.8%) indicated that they used all SNSs for academic purposes.[7]

[7] The figures given in the description of the results include the 10 who indicated all SNSs were used

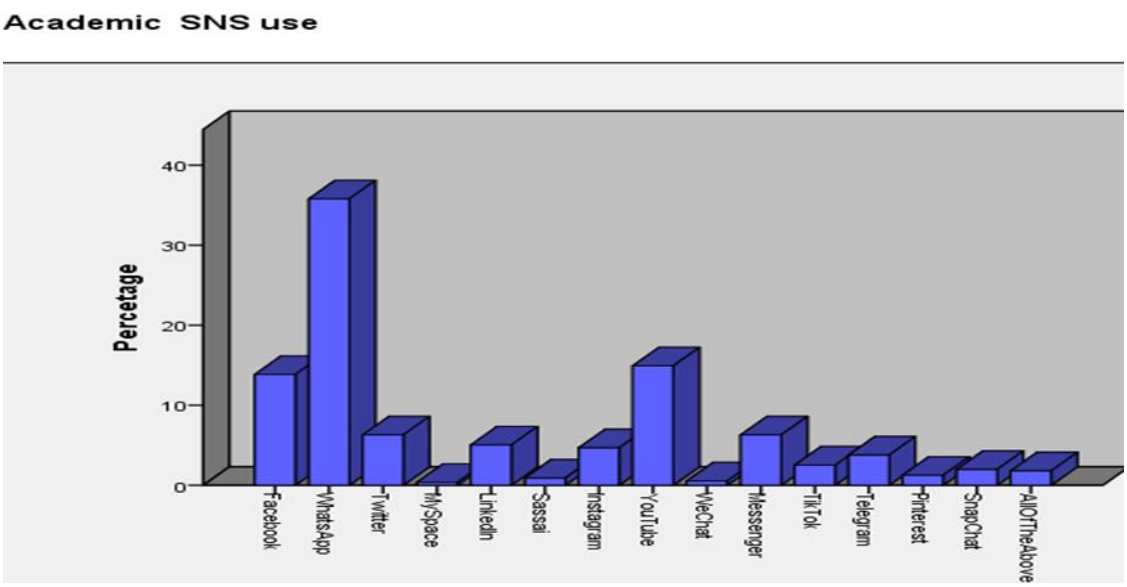


Figure 7.8: SNSs used for academic purposes

7.2.2.7 Communication

This section sought to learn if the university was taking the initiative to communicate with students via social networking sites. as shown in figure 7.9, the response was overwhelming, with 79% saying the university used SNSs, with only 5% declaring it did not. Participants who were neutral scored 16%, although in our case, those who responded with Maybe (Neutral) were included in the same criteria as those who responded Yes.

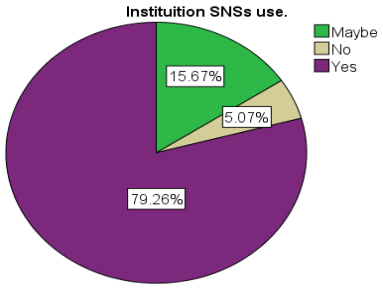


Figure 7.9: Communication Via SNSs

7.2.2.8 SNSs Mostly Used by the University

In figure 7.10 the university regarded WhatsApp (195, 43%) and Facebook (109, 24%) as the most often used SNSs for communicating; YouTube got 45 (9.9%) of the votes and Twitter had 36 (7.9%). This indicates that communication is predominantly concentrated on WhatsApp and Facebook, with other platforms used at times.[8]

[8] The figures given in the description of the results include the nine who indicated they used all SNSs

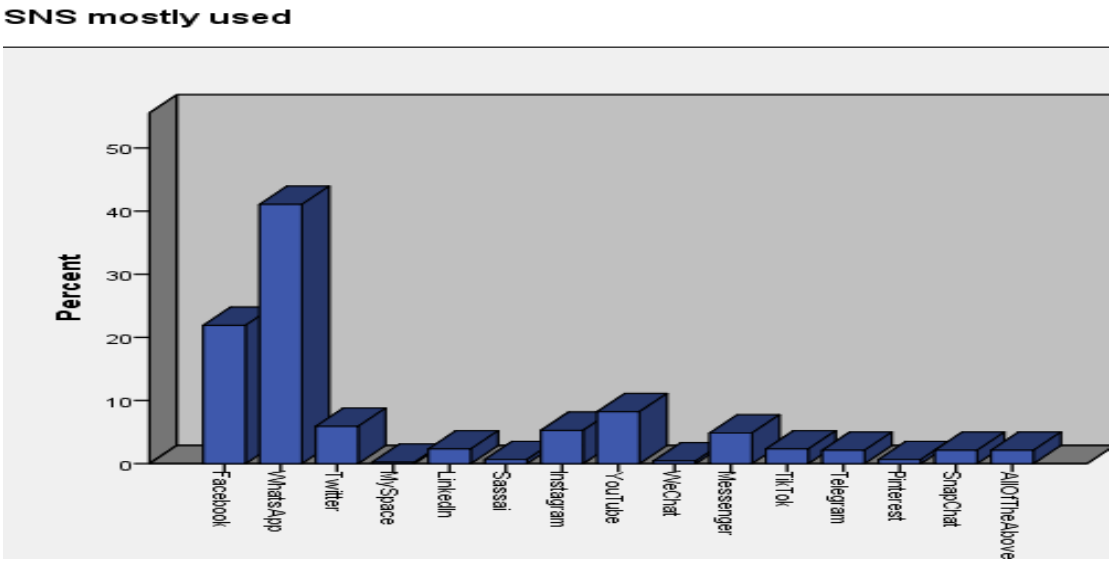


Figure 7.10 : SNSs used for communications by the university

7.2.2.9 The Uses of SNSs by the Universities

The respondents voted for all five suggested uses of SNSs, meaning that the universities are effectively using the SNSs stated above (Figure 7.11) for announcements (RA) (181), to facilitate the creation of groups for group discussions (CGD) (180), to receive learning materials (RLM) (161), as a platform for the submission of assignments and other tasks given (SA) (104), and a platform for posting feedback on lessons (PF) (104).

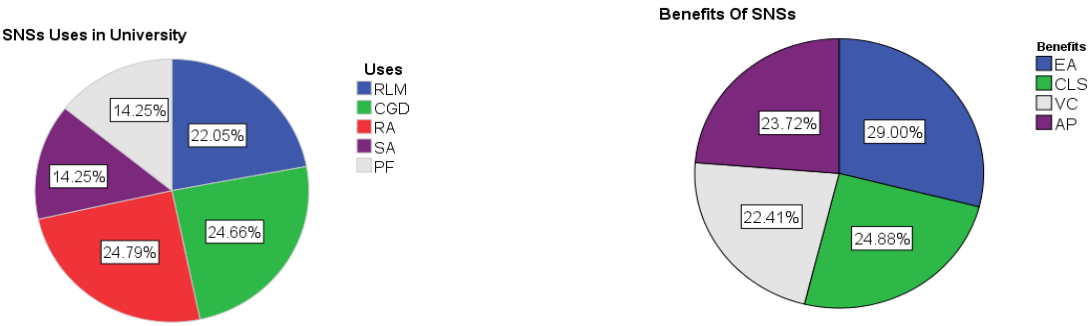


Figure 7.11: Uses and benefits of SNSs

7.2.2.10 Benefits of SNSs According to Students

The students cited the following benefits of universities using SNSs to enhance their eLearning processes: ease of access to learning materials (ES) (176), easy two-way communication between lecturers and students (CLS) (151), students lacking confidence in asking questions in class and sharing ideas can do so freely (AP) (144), video clips can be played several times until the student better understands the concepts (VC) (136).

7.2.3 Similarities and Differences Between Social Networking Platforms

In this section, the study sought to find out if there are any similarities and differences between the SNSs under study. This was done by listing the characteristics, features and uses of the SNSs studied

in Chapter 2 and Chapter 3 and then asking the participants to match each of the features and uses against the SNS that applies to them. From Table A1 (see Appendix 4), 23 characteristics/features/uses were listed and from the responses, WhatsApp and Facebook share many common characteristics/features/uses since they each have high numbers of votes on all characteristics/features/uses listed, for example, on channels of communication, Facebook had 114 votes, and WhatsApp had 283 votes, meaning Facebook and WhatsApp possess the channels of communication feature; therefore, they are similar in that respect and if that feature is absent, the SNSs are different in that respect. The table shows that although the extent of similarity may be low, these SNSs are similar in some way; for example, all of them were listed as channels of communication and disseminate information and can be used as channels of knowledge exchange, to mention a few.

7.2.3.1Key to the Characteristics/Features/Uses of SNSs

We had to select keys or acronyms representing the characteristics/features/uses to represent the data satisfactorily since some were very long statements. The (L) in the table indicates that the key might contain an L at the end; for example, Channels for Communication could be represented as CH or CHL. This key can be used throughout the document; the key table can be found in Table A2 (see Appendix 4).

7.2.4 How can Federated SNSs be used as an eLearning Tool?

The study required the actual development units of the framework; as such, the information provided in this section was incorporated to improve the 'skeletons' compiled in Chapter 4 using the extant literature. The FSNS should have features, characteristics and uses similar to the extant SNSs to negate the need for the users to learn how to use them; indeed, the FSNSs should be user-friendly and easy to navigate to ensure the smooth flow of learning and teaching.

7.2.4.1 SNSs that should be incorporated in federated SNSs

Figure 7.12 below presents the SNSs that should be included in the federated SNS. Although WhatsApp (254, 27.5%), Facebook (179, 18.7%) and YouTube (15, 15.9%) garnered the largest number of respondents, all 14 SNSs listed had a chance of being selected for inclusion[9].

[9] The figures given in the description of the results include the 38 who indicated all SNSs were included

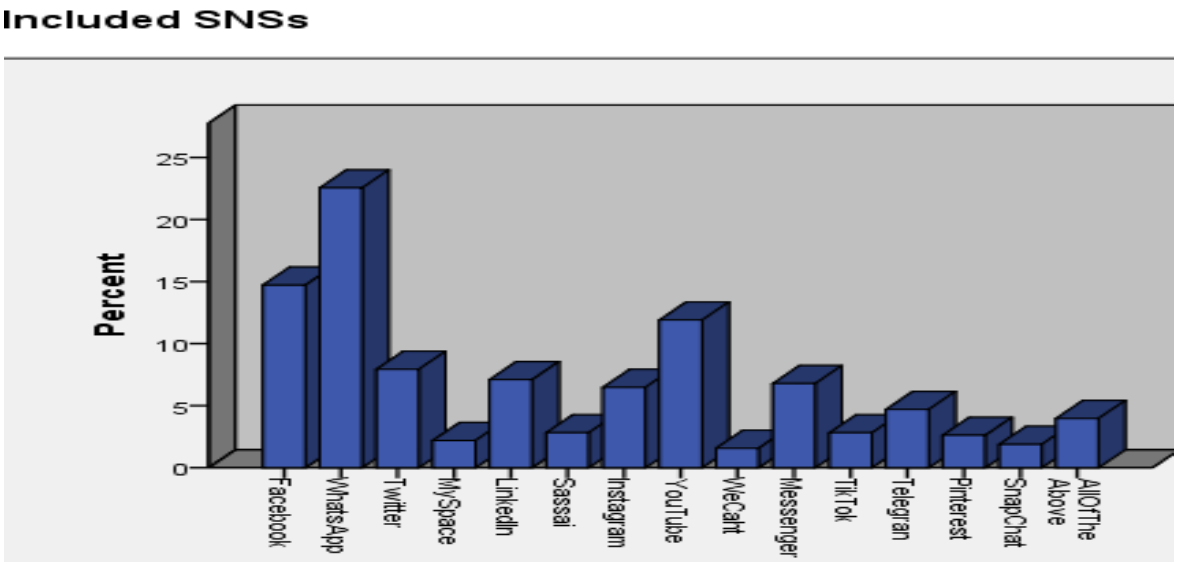


Figure 7.12: Services to be included in SNSs

7.2.4.2 Services

The study summarised the findings from the extant literature into 14 services offered by SNSs, and from these, the respondents were asked to choose the services that should be included in the FSN. The highest number of respondents indicated that all services should be offered, figure 7.13.

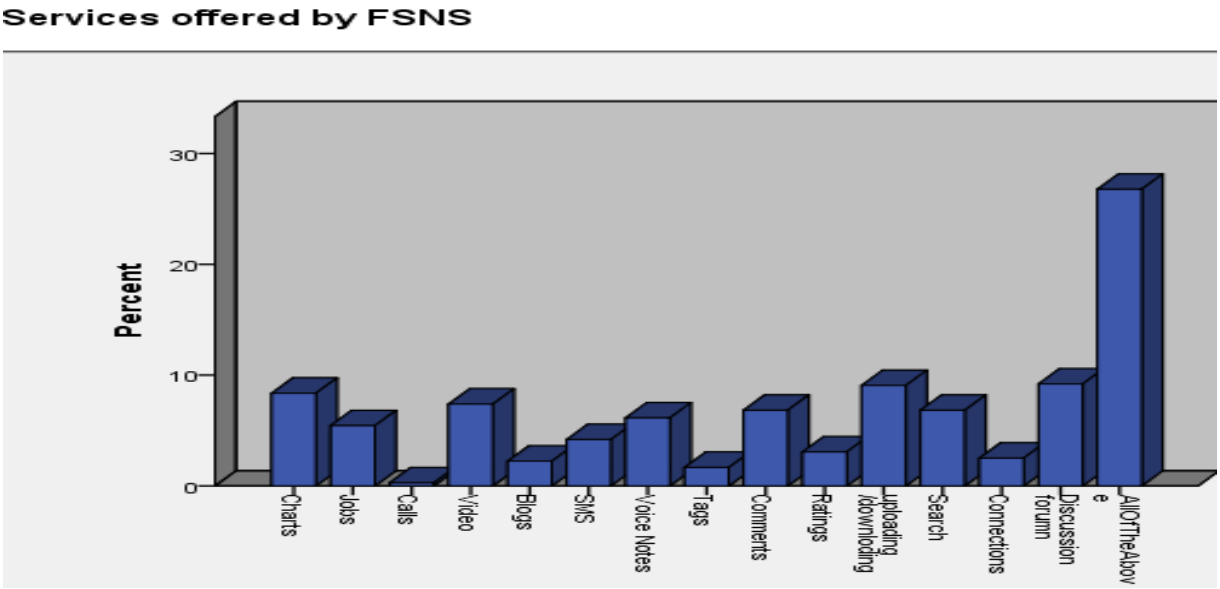


Figure 7.13: Services offered by SNSs

7.2.4.3 Characteristics, features and uses

The FSNS to be developed should be described by certain characteristics, features and uses, given that in Table 1 (see Appendix 4), the similarities and differences between the SNSs are indicated (Figure 7.14), and respondents were asked to select all the characteristics, features and uses that should shape the proposed FSNS. The characteristics/features/use that respondents voted for are channels for communication (157, 13.6%), research (145,13%), knowledge exchange (144, 12.9%) and encouraged interactivity in both peer and academic support (102, 10.8%).

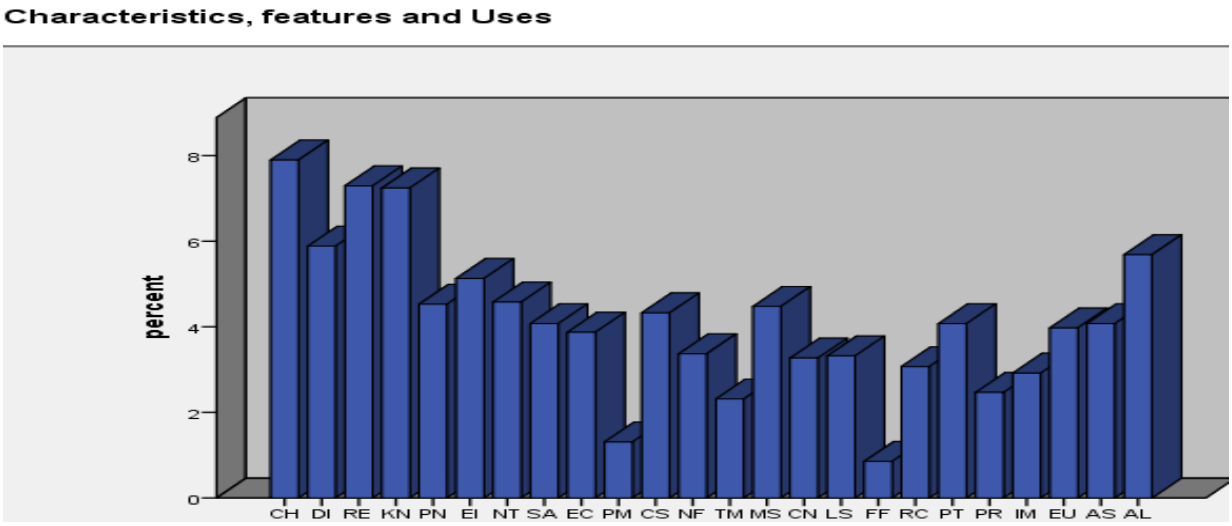
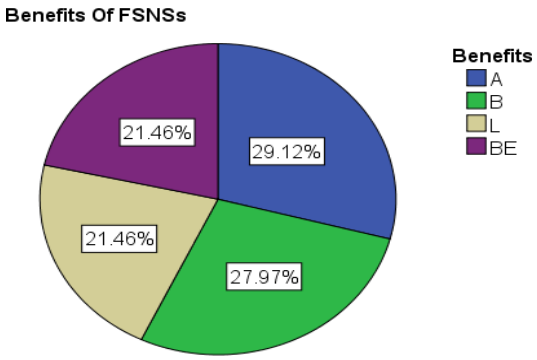


Figure 7.14: Characteristics, features and uses

7.2.4.4 Benefits of FSNs and eLearning model currently used

The benefits of FSNSs selected were: avoid spending too much time on non-educational materials during studying hours (A) (228), be motivated to study by continuously being reminded of schoolwork by the federated social networking environment (B) (219), learn without limits (L) (168), and be confident with the security of my data (BE) (168). Respondents were asked to choose the eLearning mode they were using; some indicated they were using an SNSs model, and others indicated they used a general ICT model. They replied that such uses were: receiving course materials (84,169), a discussion space with your facilitators (79,124), an assessment feedback platform (61,125), a notices platform (61,138), and for an SNSs model and general ICT, respectively. These results are presented in the charts, figure 7.15 below



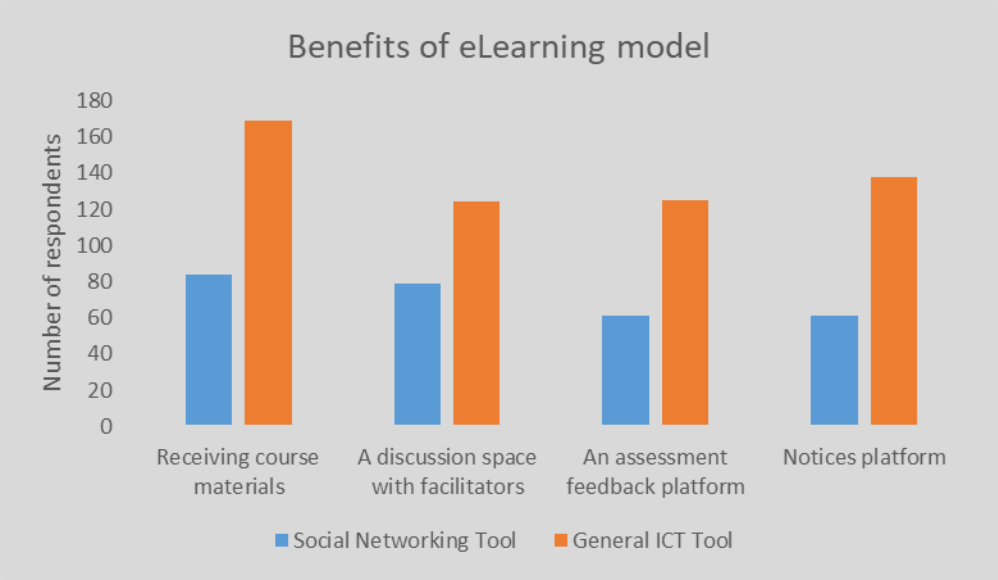


Figure 7.15: Benefits of FSNs and benefits of SNSs according to type of eLearning models given

7.2.4.6 Compulsory use of eLearning with the university

In figure 7.16 two hundred and forty-seven out of 316 students indicated that the use of an eLearning model was compulsory at the university, while 35 denied that, and 34 were not sure. The university has embraced the eLearning facility, and most students are using it, which allowed us to introduce an FSNS as an eLearning tool, noting that there would be very little resistance to change since they have been using it one way or the other.

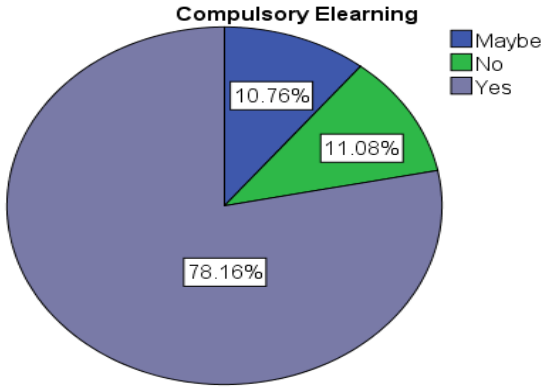


Figure 7.16: Compulsory use of eLearning

7.2.5 Preparing data for statistical analysis

This preparation was done to ensure the data was suitable for statistical analysis and also to select the right statistical tools for analysis.

7.2.5.1 Missing values and outliers and normality testing

Missing values in the data were dealt with in the design of the questionnaires, where questions were marked compulsory. Data normality testing found that the sign value of the items was less than 0.05 in both the Kolmogorov–Smirnov and Shapiro–Wilk tests; accordingly, the study used non-parametric tests for data analysis.

7.2.5.2 Reliability of the research instrument

A reliability test was conducted to determine if the questionnaire survey constituted a reliable instrument for assessing the responses from the students. All the items under the student survey were tested using the Cronbach 's alpha (α) measure. Although only a snippet of the items is represented in the table below, all the items tested and satisfied the requirements of Cronbach's alpha (α). George and Mallery (2003) in Gliem and Gliem (2003, p. 87) provide the following rules of thumb, table 7.1:

Table 7. 1: Cronbach's alpha rule of thumb

Alpha	Comment
_ > .9	Excellent
_ > .8	Good
_ > .7	Acceptable
_ > .6	Questionable
_ > .5	Poor
_ < .5	Unacceptable

Therefore, the results shown by the reliability test in both tables (table 7.2 and table A3) indicate that the reliability was very good as the alpha (α) is greater than 0.9.

Table 7. 2 Reliability statistics

Cronbach's Alpha	N of Items
.936	484

Source: Primary Data, 2021

7.2.5.3 Snippet of detailed results

The reliability test of the item-total statistics achieved an average of 0.9, which is an excellent alpha on all items in the questionnaire. The study took only a snippet, Table A3 (see Appendix 4) of the first item since all items could not be presented. A total number of 484 items were tested.

7.2.5.4 Determining the correlation of variables

This determination was done using Spearman's correlation coefficient for the bivariate analysis seeking to find the relationship between age, gender and area of specialisation, whether or not they are directly or inversely related to SNSs membership. The Kruskal–Wallis test was done to verify whether or not specialisation or area of study affected SNSs membership. The main thrust was to determine if those three factors affected SNSs membership. The first study was undertaken as an analysis between each of the three selected variables against the SNSs membership variable and the study done in Table A4 (see Appendix 4) shows that there is no relationship between students' SNSs membership and the three demographic variables age (0.090), gender (0.017) and area of study (-0.056). This is according to the rule of thumb given by Hinkle (2003) in Mukaka (2012, p. 71), presented as follows:

- .90 to 1.00 (-0.90 to-1.00) means very high positive (negative) correlation
- .70 to .90 (-.70 to -.90) means high positive (negative) correlation

- .50 to .70 (-.50 to -.70) means moderate positive (negative) correlation
- .30 to .50 (-.30 to -.50) means low positive (negative) correlation
- .00 to .30 (.00 to -.30) means negligible correlation

The other test took one of the three variables, the area of study to ascertain if SNS membership is affected by the student's area of study. The Kruskal–Wallis test presented in table 7.3 below also shows that the SNSs are not in any way related to the area of study and the different specialisation area groups have no significant impact (0.148 which is >0.05), hence the study automatically qualifies to be conducted, irrespective of the area of study.

Table 7. 3: Kruskal–Wallis test

	SNSsMEMBER
Chi-Square	5.348
Df	3
Asymp. Sig.	.148

Source: Primary Data, 2021

7.2.5.5 Factor analysis

Factor analysis was conducted on characteristics, features and uses to group the 23 items into a manageable number of components. The KMO and Bartlett's tests were done to test if the data were fit to be considered for factor analysis; the results in Table 7.4 confirm that the data are fit to be factored with a p=0.000 and X^2=5233.951 on Bartlett's test and a KMO of 0.951, which is greater than the minimum value of 0.5.

Table 7. 4: KMO and Bartlett's Test

KMO and Bartlett's Test		
Kaiser–Meyer–Olkin measure of sampling adequacy.		.951
Bartlett's test of sphericity	Approx. Chi-Square	5233.951
	Df	253
	Sig.	.000

Source: Primary Data, 2021

From the 23 components, three components scored an Eigenvalue of 1 and above. From those three components, we have a 64.042% in square loadings, which is above half of the total variance. These three components indicated that characteristics, features and uses could be grouped into three categories, where the individual factors would fall according to the type of an item. The first component reached a very high Eigenvalue of 12.119, the second component had 1.609, and the third component had 1.002. Table A5 (see Appendix 4).

The study further conducted a factor rotation using the Varimax method to assess the strength of correlation among the items under analysis, and each component was loaded with items with a strong correlation strength. Items falling into more than one group were deleted from the group or component that was loaded with a weaker coefficient. Variables that were considered had factor loadings of 0.5 and above, these were taken to represent one out of the three categories they fall into. The categories referred to above as characteristics, features and uses. The first component with an Eigenvalue of 12.119 was loaded with 14 items with loadings of more than 0.5, the second component with an Eigenvalue of 1.609 was loaded with six items, and the third component with an Eigenvalue of 1.002 was loaded with three items from a total of 23 items. This means when grouping the components, we focus on the extent of correlation, of which the higher the value the more they represent that component or category. Table A6 (see Appendix 4).

7.2.5.6 Hypothesis testing

Hypothesis testing was conducted on the three independent variables of age, gender and area of study against the dependent variable of SNS subscription, table 7.5. This was done to test if these independent variables affect the subscription to SNSs in tertiary institutions. Hypothesis testing was done using the Kruskal–Wallis test; the assumptions were declared in Section 7.2.1.1 where:

Age **H_0**: University student's Age has no effect on SNS subscription.
Area of Study **H_0**: Student's Area of study has no effect on SNS subscription
Gender **H_0**: Student's Gender has no effect on SNS subscription

Table 7. 5 SNSs member

	Age	Gender	Area of Study
Chi-Square	7.140	.188	5.348
Df	5	2	3
Asymp. Sig.	.293	.910	.148

a. Kruskal Wallis Test

b. Grouping Variable: Age, Gender and Area of Study

Source: Primary Data, 2021

From the Kruskal–Wallis test, the of age asymptotic significance was 0.293, the asymptotic significance of gender was 0.910, and the asymptotic significance of area of specialisation was 0.148, which is greater than 0.05. Thus, we failed to reject the null hypothesis, which states that age, gender and area of specialisation has no effect on SNS subscription in university institutions.

7.3 Lecturers' Data

The main users of the framework are students and lecturers; for students to receive assignments and collaborate, they need material prepared by the lecturers. Uploading eLearning material, uploading assessment material, downloading work submitted by students and online lectures can be effected through the FSNSs. This eLearning tool can be used as an asynchronous or synchronous way of teaching, whereby lecturers can conduct online lectures, upload pre-recorded lectures and even upload other learning material for student consumption at their convenience (Blezu and Popa, 2008; Gilbert, 2015; Kuimova, Kiyanitsyna and Truntyagin, 2016; Mukhtar *et al.*, 2020).

7.3.1 Demographic data presentation of lecturer and student response rates

In this section, the ages, gender, marital status, degree status and area of study of the participating lecturers are presented for us to gain general knowledge of the participants in the study. The response rate enabled us to ascertain if the sample size was sufficiently representative of the population.

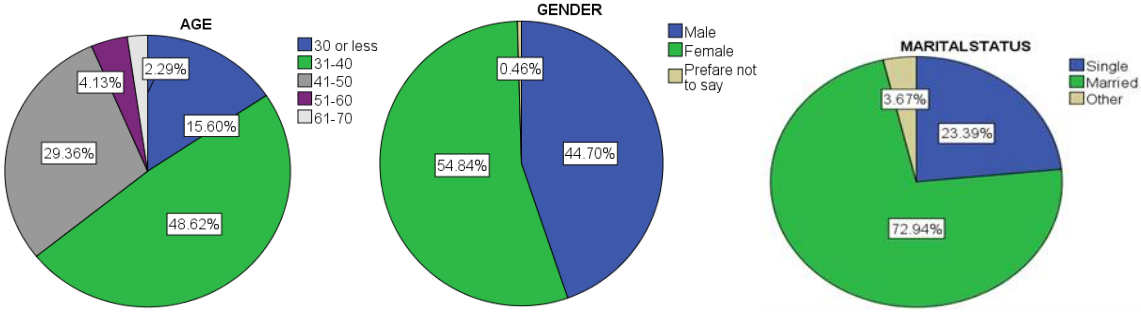
7.3.1.1 Demographic data presentation of lecturer respondents

Technology-enhanced tools are usually embraced by a particular age group, whether or not they are academics (Cachia, 2008; Christofides, Muise & Desmarais, 2010; Holland, 2017; Musungwini et al., 2016; Zanamwe et al., 2013); accordingly, the study wanted to clarify the claim. Further, it is assumed that the different areas of specialisation affect the way lecturers enjoy teaching and providing reading material online. This section also has hypothesis declarations:

Age **H_0**: University Lecturer's Age has no effect on SNS subscription.

Area of Specialisation **H_0**: Lecturer's Area of specialisation has no effect on SNS subscription

Gender **H_0**: Lecturer's Gender has no effect on SNS subscription



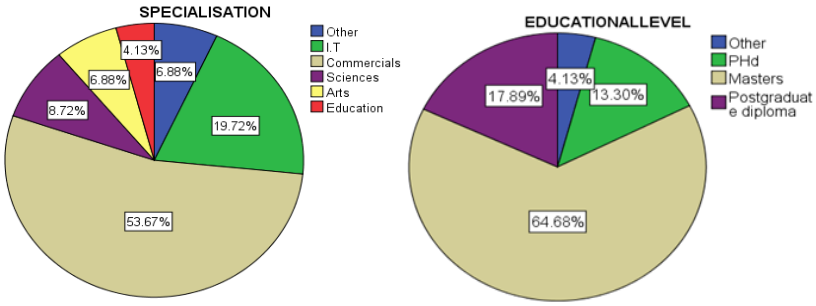


Figure 7.17: Demographic (age, gender, marital status and educational level)

As can be seen in Figure 7.17, women represented 45% of the respondents, while men represented 54.6%, and the remaining percentage of 0.5% preferred not to disclose their gender. These results may suggest that most universities in Zimbabwe are dominated by male lecturers and that female lecturers might be affected by the root culture, whereby female children are still being deprived of an education and are vulnerable to child marriages (UN Condemns Zimbabwe Child Marriages as Girl Dies after Giving Birth, 2021). From the results, the majority (64.2%) of respondents were less or equal to 40 years old, which suggested that the educational institutions were dominated by middle-aged adults. The marital status results suggested that the majority (72.9%) were married, 23.4% were single, and 3.7% fell under 'other'. Regarding education, the results revealed that the majority (64.7%) of the respondents held a Master's degree, followed by (17.9%) with a PhD (13.3%) and other qualifications (4.1%). The results suggest that most of the lecturers are still obtaining a PhD degree: either registered and working towards the degree or considering registering. More than half of the respondents were from the commercial department (53.7%), followed by IT (19.7%), sciences (8.75%), arts and other tied (7.9%), with the lowest percentage from education at (4.1%).

7.3.1.2 Response rate

We sent 300 questionnaires to lecturers, of which 218 were returned, which yielded a response rate of 72%, which is above 70%. Sivo et al. (2006) in (Mahlangu, 2020) support that such a response rate is good and, therefore, the validity of data is not compromised since it depends on the response rate achieved, according to Morton et al. (2012) in (Mahlangu, 2020). Using the formula given by (Nooshinfard et al. (2012, p. 51) in figure 7.18:

$$\frac{\text{Number of usable responses}}{\text{Total sample- Unsuitable /uncontactable units}} * 100\%$$

Figure 7.18: Response rate

7.3.2 Social networking site types, usages and benefits.

The study needed to determine the respondents' SNS usage regarding the types of SNSs used and gain knowledge on the benefits they deemed having gained from using these SNSs. The usage and benefits were expected to be both educational and non-educational, which helped the study deduce the normal utilisation of SNSs for the framework development to be prepared by considering their responses and

applying measures to reduce non-educational uses of SNSs on FSNSs. The benefits presented in the questionnaires were taken from the literature (Cachia, 2008; Dlamini et al., 2015; Eke et al., 2014; Kaplan & Haenlein, 2010; Pempek et al., 2009) and are presented in Chapter 2 and Chapter 3 of this thesis.

7.3.2.1 Social networking site usage.

The study sought to analyse the number of SNSs users to learn if the users were indeed using these SNSs. Since the study's main objective is to develop an FSNS it required users of SNSs to participate.

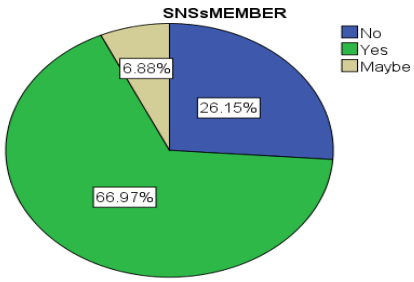


Figure 7.19: SNSs membership

Figure 7.19 above displays that 67% of the respondents indicated that they used SNSs, while 26.2 % claimed that they do not use SNSs, and 6.9 % were neutral. Those using SNSs or were neutral combined were the highest percentage of 73.9%, meaning that the part needing to be answered by those respondents would contain a fair portion of the respondents, and their responses could safely be taken as a true representation of the population.

Regarding participants who responded Yes and Maybe on whether they were subscribers to SNSs, the study analysed the numbers of those who used specific SNSs, and the results (figure 7.20) show that WhatsApp is the most popular, with a total of 158 out of 161 users (17.9 %), followed by Facebook with 145 (17.3%), YouTube 120 (13.5%), Twitter 92 (10.3%) and LinkedIn 82 (9.2%). These were selected as the top five used by students for general use, whereas Telegram had the smallest number of users (6).[10]

[10] The figures given in the description of the results include the two who indicated they used all SNSs

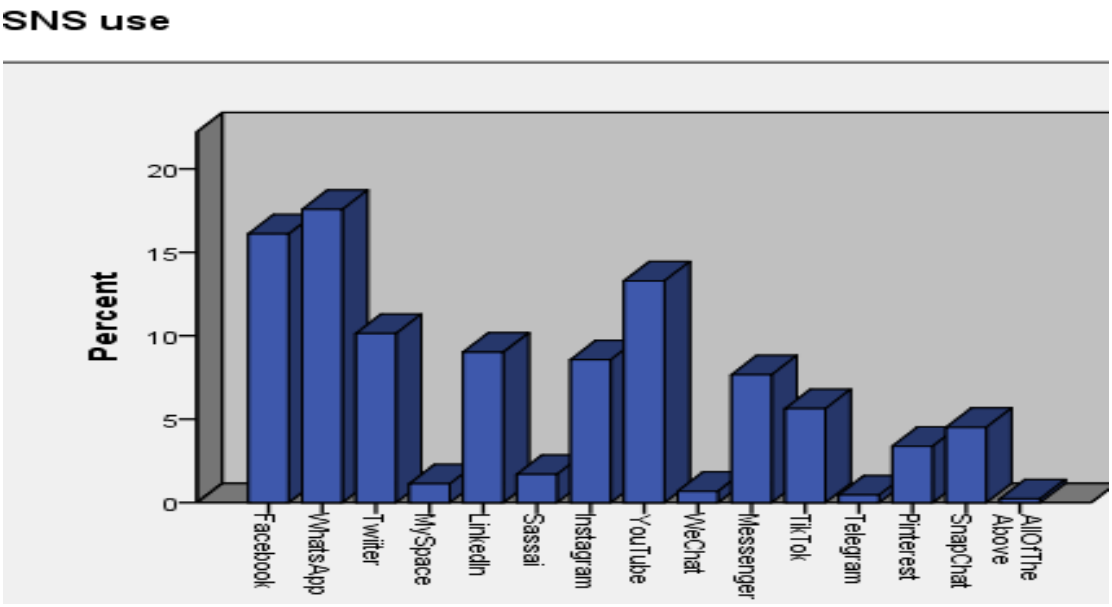


Figure 7.20: SNSs subscribers

7.3.2.2 SNSs subscribed to by each member

The survey also assessed the number of SNSs subscribed to by each respondent (see Figure 7.21); this information is crucial to obtain an overview of the number of SNSs to be included in the federated networking sites using these results as a guide. The highest number of SNSs subscribed to by the respondents was 15 by two respondents, followed by 11 accounts by three respondents, and 10 SNSs were subscribed to by five respondents from the sample. The highest number of respondents (30) indicated they were subscribed to five SNSs.

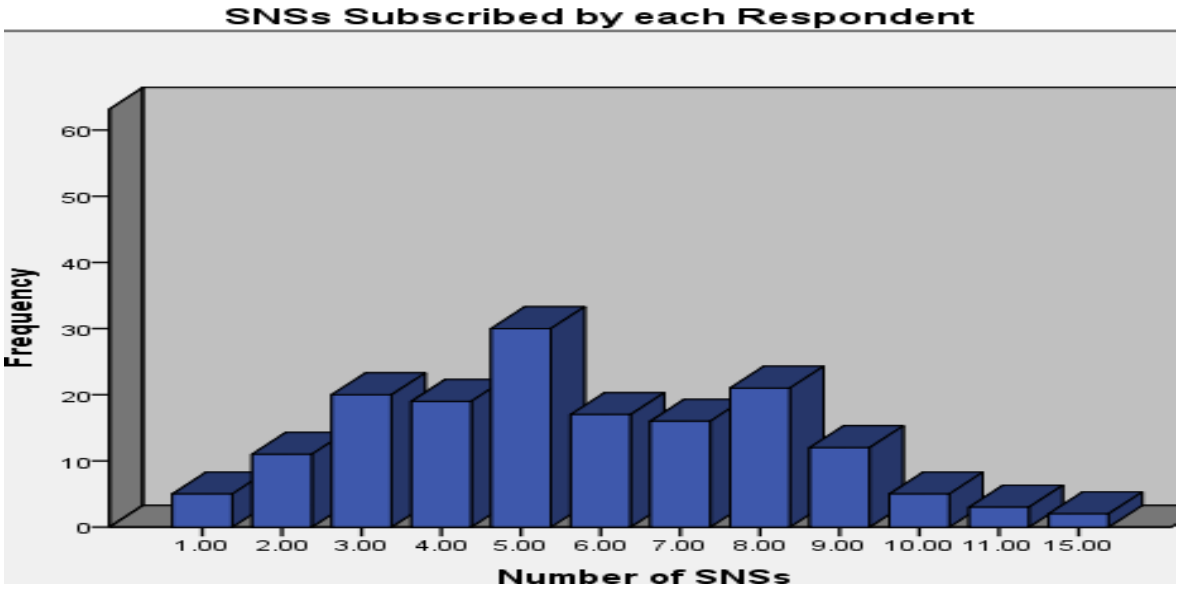


Figure 7.21: SNSs subscribed to by each lecturer

7.3.2.3 Perceived reasons for SNS use by students

Lecturers were asked what they perceived to be the reasons for SNS use by students, and they responded by indicating that SNSs help students better understand (31.3%), motivate students to have open discussions (32.9%), hinder students in concentrating on school issues (19 %), give students unnecessary freedom than recommended (15%) and other reasons (1.8%). Figure 7.22 presents the perceived uses of SNSs.

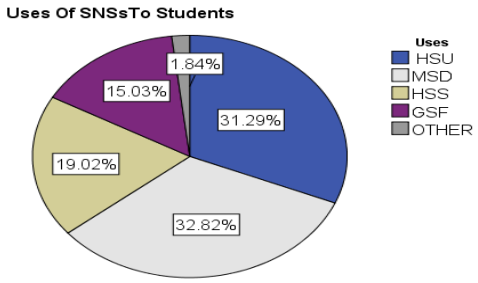


Figure 7.22: Perceived uses of SNSs

7.3.2.4 Frequency of SNS use

The study sought to analyse the usage patterns of the participating lecturers. Such information was required since the FSNS is expected to be used daily, meaning SNSs should be an integral part of their daily activities for them to embrace the FSNS tool.

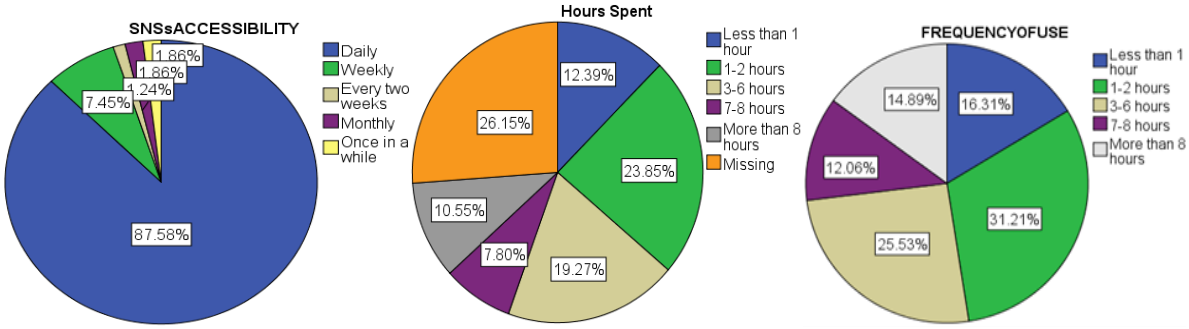


Figure 7.23: SNS accessibility, frequency of use and hours spent

Figure 7.23 above shows that SNSs are visited by lecturers routinely, with 87.6% of the respondents using SNSs daily, of which 83.7 % spent at least an hour on SNSs. Figure 7.23 also indicates that 1.9% of respondents visit SNSs occasionally, of which 17.3% indicated that they only used it for less than an hour. These results confirm that lecturers are regularly on SNSs, which means it would be very easy for them to switch between personal business and work, meaning they would be working in the same environment as their personal environment.

7.3.2.5 Internet access

In figure 7.24 most of the respondents have now embraced internet life since the highest number (34.9%) of respondents indicated that they moved around with their internet, meaning anything to do with the internet can be done anywhere and anytime, and the second highest percentage (31.6%) stated

that they accessed the internet at home, while 29.2% indicated they accessed the internet on campus, and only 4.3% visit internet cafés to access the internet.

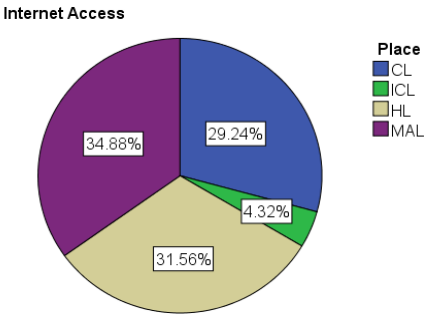


Figure 7.24: Internet accessibility

7.3.2.6: Reasons why university lecturers use SNSs

At this point of the study, we wanted to learn the reasons for the respondents' SNS use; although there are many reasons, Figure 7.25 details the main reasons, namely general and academic reasons for using SNSs. Regarding the general reasons for using SNSs, most (145, 36.7%) of the respondents indicated they needed to stay in touch with their families and friends (KFF), followed by fun and entertainment (FE) (106,26.8%), whereas 80 (20.3%) respondents selected maintaining existing friends (MEF) and 64 (16.2%) indicated making new friends (MF). Academic reasons and research(res) scored the top number (129, 23.7%) of votes, although the results explain that all the given reasons, i.e., discussion space(DS) (113,20.8%), sending and receiving emails (SR) (111,20.4%), posting course material (PC) (96,17.6%), and collaboration (COL) (96,17.6%) in order of the most voted for, are equally important.

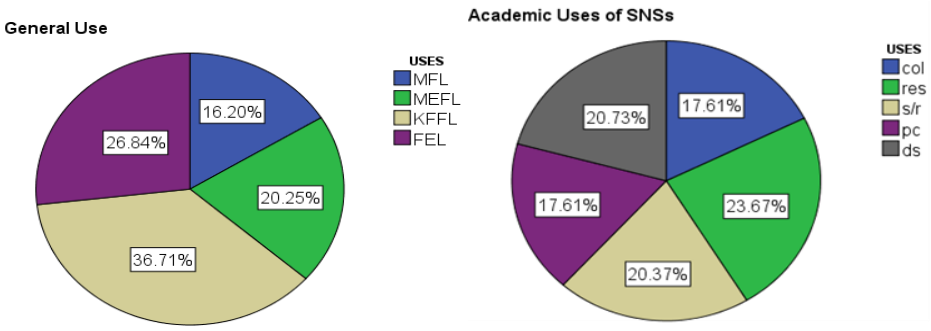


Figure 7.25: General and academic uses of SNSs

7.3.2.7 SNSs used for academic purposes

Lecturers rated WhatsApp as their number one platform used for academic purposes, predominantly because students can access WhatsApp at low communication costs and moreover, can communicate with friends and relatives on the same monthly data bundle, unlike some eLearning tools like Facebook that require a considerable amount of data to access and is not popular as an affordable way of communication. Most adults use WhatsApp for communication, while Facebook is mostly used for updates on their everyday environments. Indeed, the WhatsApp platform has been adopted as a basic

form of communication since it cuts across all nations and has lower data cost subscription. in figure 7.26 one hundred and fifty-eight (28.2%) lecturers voted for WhatsApp as one of the platforms they used for academic purposes, followed by Facebook with 101 (18%) and YouTube with 74 (13.2%). Of these Lectures, 2 (0.4%) indicated that they used all SNSs for academic purposes.[11]

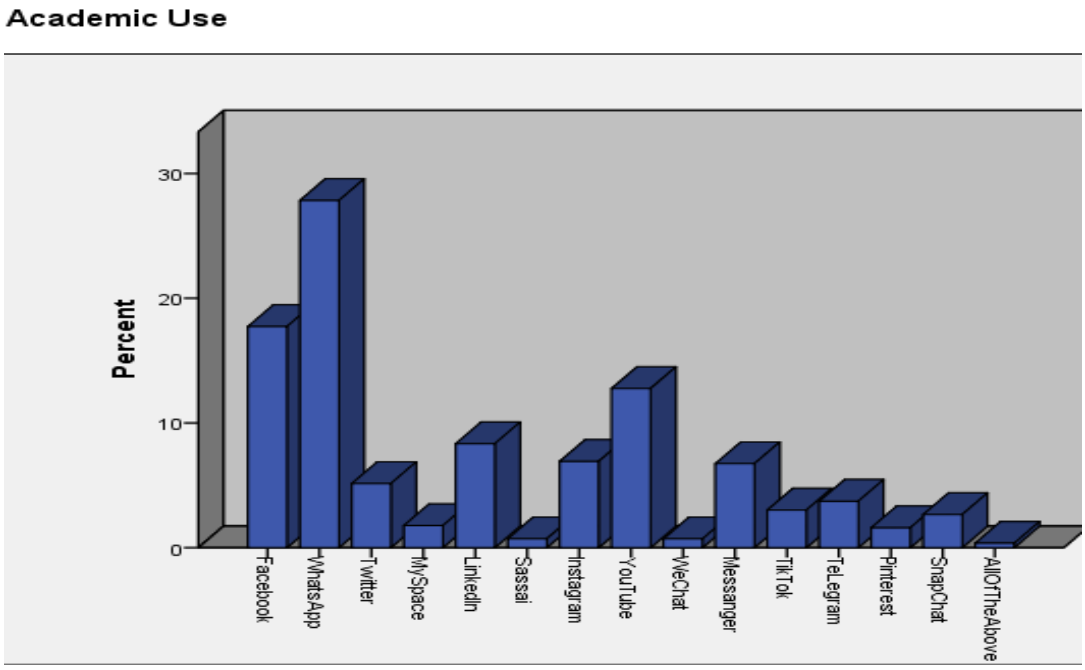


Figure 7.26: SNSs used for academic purposes

7.3.2.8 Communication

This section sought to determine if the university was proactive in communicating with students via social networking sites. The response was overwhelming (figure 7.27), with 74% stating that the university uses SNSs, with only 13% disagreeing and having a neutral position at 13%, although in this case, the study includes the Maybe (neutral) response with the same criteria as those who replied Yes.

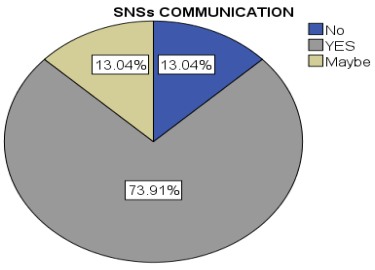


Figure 7.27: Communication Via SNSs

7.3.2.9 SNSs mostly used by universities

WhatsApp at 128 (34.6%) and Facebook at 84 (22.7%) were the SNSs most often used by the university for communication; Twitter had 43 (11.6%) and YouTube 38 (10.2%) votes, indicating that

[11] **The figures in the description above includes the two respondents who indicated all SNSs are used for academic purposes**

communication is mainly concentrated on WhatsApp and Facebook, while other platforms are not frequently used, figure 7.28.[12]

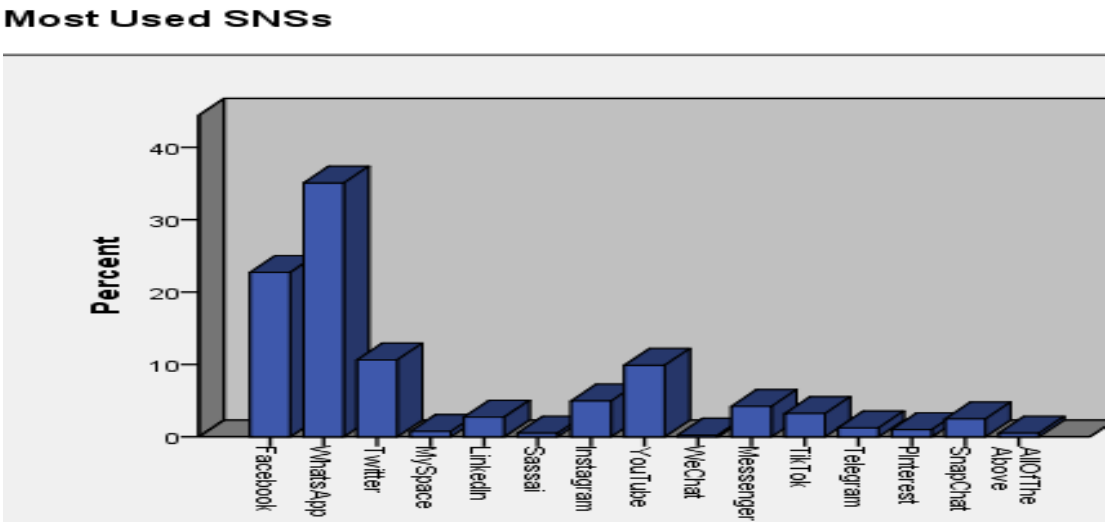


Figure 7.28: SNSs used for communications by university

7.3.2.9 The uses of SNSs by the Universities

All the five suggested uses of SNSs were voted for by the respondents, meaning that the universities are effectively using the SNSs stated above (Figure 7.28). In figure 7.29, regarding announcements (RA), 74 agreed the universities employed SNSs to facilitate the creation of groups for group discussions (CGD); 105 for sending learning materials (SLM); 95 as a platform for posting assignments and other tasks (PA) 142; and 68, platforms for posting feedback on lessons learnt (PF).

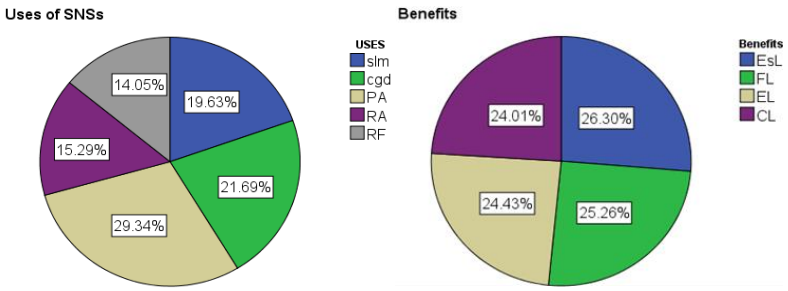


Figure 7.29: Uses and benefits of SNSs

7.3.2.10 Benefits of SNSs according to lecturers

The lecturers cited the benefits in Figure 7.29 as being a result of universities' use of SNSs to enhance their eLearning processes; all lecturers were subscribers to at least one social networking platform, and thus, messages were guaranteed to reach the intended recipients (ESL) (126), facilitate eased of two-way communication between the lecturers and students (FL) (121) conveyance of messages (EL) (117) and lastly, a cheaper means of communicating (CL) (115).

[12] **The figures given in the description of the results include the two who indicated they used all SNSs**

7.3.2.11 SNS feedback

This section scrutinises the effectiveness of SNS communication. If two-way communication existed, we assumed there was effective communication. The bigger portion of the sample indicated that there is two-way communication. Figure 7.30 represents the data.

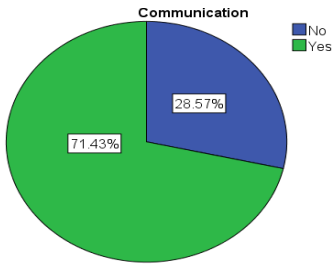


Figure 7.30: Feedback from students

7.3.3 Similarities and differences between the social networking platforms

This section of the study describes that the questionnaires were designed in such a way that the lecturers' responses would shed light on the similarities and differences between the SNSs under study. The items listed on the answer grid were the characteristics, features and uses of the SNSs studied in Chapters 2 and 3, where some of the literature consulted includes Alassiri (2014), Bonds-Raacke and Raacke (2010), Branden (2011), Braun (2017) Cachia (2008), Munene and Nyaribo (2013) and Sungkur and Rungen (2014). From Table 7 (see Appendix 4), 23 characteristics/features/uses were also listed for the lecturers on which to provide their points of view. Their responses revealed that WhatsApp and Facebook shared many common characteristics/features/uses since both SNSs received a high number of votes on all characteristics/features/uses listed. For example, regarding research, Facebook had a total of 55, and WhatsApp had a total of 54 votes, meaning both Facebook and WhatsApp possess the dissemination of information feature; therefore, they are similar regarding that feature. Conversely, if that feature is not present, the SNSs are different in that regard. The table shows that although the extent of similarity may be low, these SNSs are similar in some way; for example, all of them were listed as a platform of knowledge exchange for the establishment of professional networking, and where they enhance the construction of students' learning and the continuation of their engagement in development, to mention a few.

7.3.4 How can federated SNSs be used as an eLearning tool

The lecturers would communicate with their students using the FSNS, as such, they should suggest the requisite units to be added to the development of the framework. The information obtained from this section was added to improve the conceptual framework developed in Chapter 4 with the aid of the extant literature. The FSNS needed to have features, characteristics and uses similar to the extant SNSs to negate the need for the users to learn how to use it, and moreover, should be user-friendly and easy to navigate for a smooth flow of learning and teaching.

7.3.4.1 SNSs that should be incorporated in Federated SNSs

Figure 7.31 below presents the SNSs that should be included in the federated SNS. Although WhatsApp (192, 24.5%), Facebook (137,17.5%) and YouTube (135,17.2%) attracted the highest number of responses, all 14 SNSs listed were available for selection, and thus, inclusion.[13]

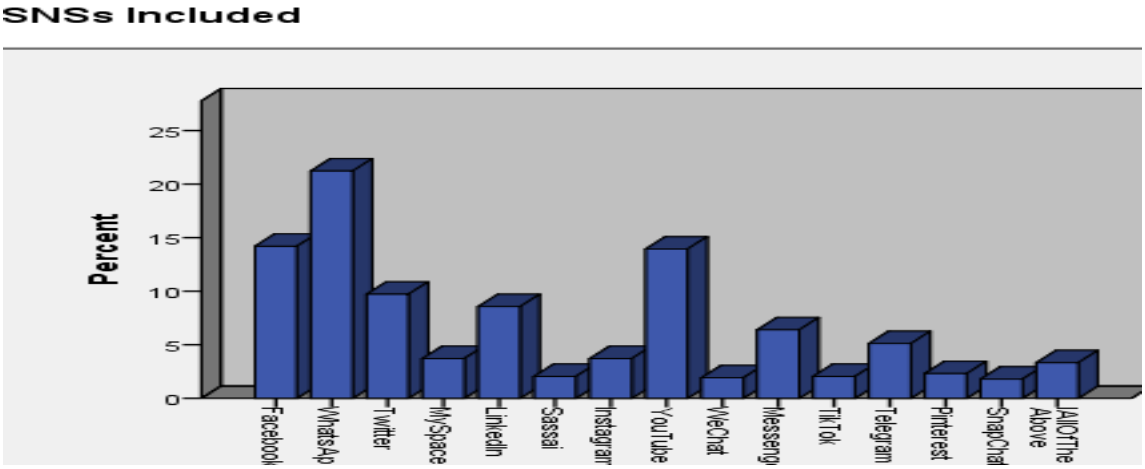


Figure 7.31: SNSs to be included in FSNSs

7.3.4.2 Services

The study summarised the findings from the extant literature into 14 services offered by SNSs, and from these, the respondents were asked to choose the services that should be included in the FSN. Figure 7.32 below indicates that seven services garnered 100 + votes, with the lowest percentage of 7.9%, meaning the lecturers suggested that those seven services should be offered, considering that the services obtained more than half of the total votes.

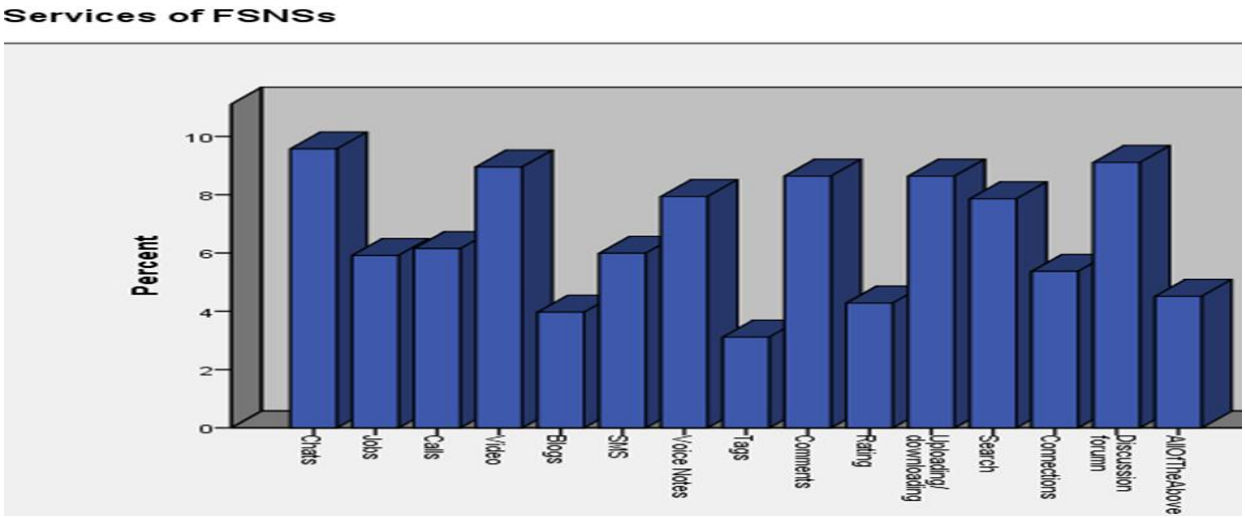


Figure 7.32: Services to be included in SNSs

7.3.4.3 Characteristics, features and uses

The FSNS to be developed should be described by certain characteristics, features and uses, in light of a reference to Table 7 (see Appendix 4) that exhibited the similarities and differences between the SNSs (Figure 7.33). The respondents were asked to choose all the characteristics, features and uses they

[13] **The figures given in the description of the results include the 26 who indicated all SNSs should be included**

deemed fit to shape the proposed FSNS. According to the listed characteristics, features and uses, Channels for communication (121, 12%), Knowledge exchange (115, 11.7%), disseminating information (105, 11%), and research (105, 11%) obtained the highest number of votes; they are presented according to the largest number of respondents who chose it.[14]

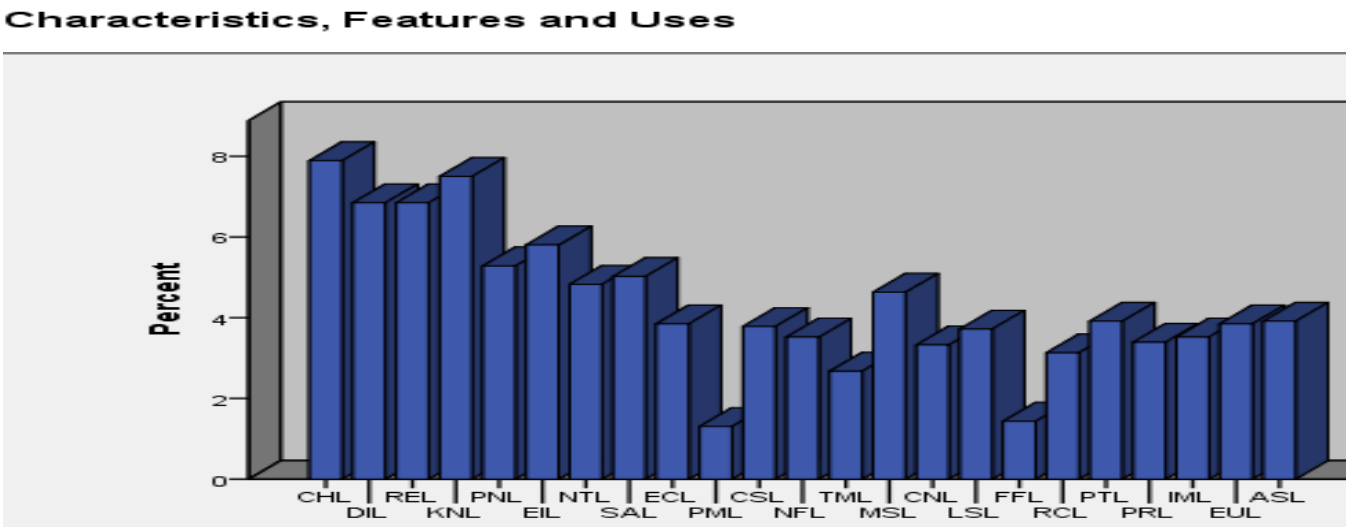


Figure 7.33: Characteristics, features and uses

7.3.4.4 eLearning model currently used by the university and its purposes (uses)

The lecturers were requested to choose the type of eLearning model they were currently using. As presented in figures 7.34 most of them (158) selected the general ICT model, and the remainder (60) chose the social networking-based model. From those eLearning models, some of the stated uses related to them, giving course materials got 180 respondents' votes, and this was divided into the general ICT-based model (134) and the social networking-based model (46); further, an assessment platform (155), divided into the general ICT-based model (123) and the social networking-based model (32); discussion space with students (153), divided into general ICT-based model (108) and social networking-based model (45); and lastly, the notices platform (151), divided into general ICT-based model (117) and social networking-based model (34).

[14] **The figures given in the description of the results include 4.5% who indicated all characteristics, features and uses should be included.**

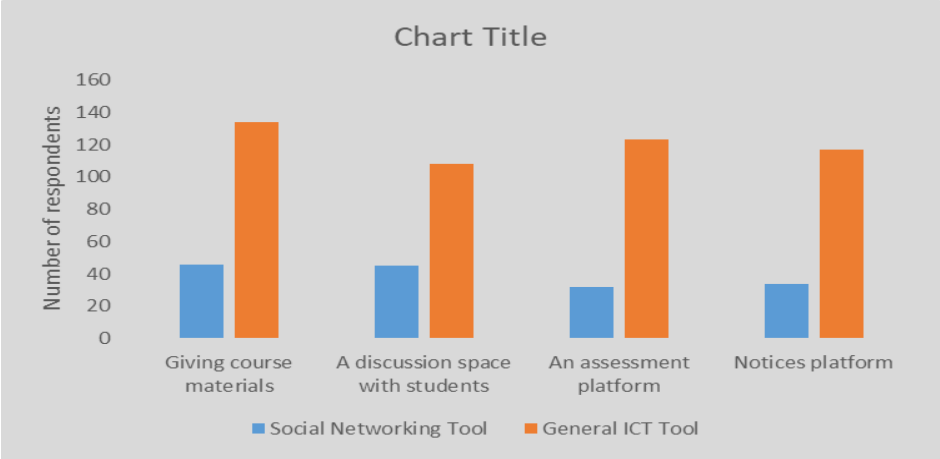


Figure 7.34: Uses of eLearning models

7.3.4.5 Compulsory use of eLearning with the university

One hundred and ninety (87,2%) of 218 lecturers indicated that the use of the eLearning model was compulsory at the university, while 11(5%) denied that, and 17 (7.8%) were not sure, the data is presented in figure 7.35. This shows that the university has embraced the eLearning facility, and most lecturers are using it, which allowed the study to introduce an FSNS as an eLearning tool, noting that there would be very little resistance to change since they had been using it in some way.

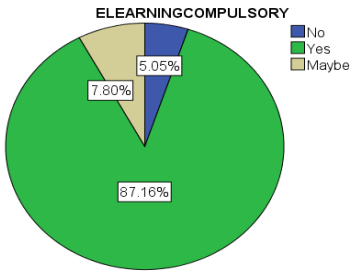


Figure 7.35: Compulsory use of eLearning

7.3.5 Preparing data for statistical analysis

This preparation ensured the data was suitable for statistical analysis and assisted in choosing the right statistical tools for analysis.

7.3.5.1 Missing values, outliers and normality testing

Missing values of data were dealt with in the design of the questionnaires, where questions were marked as compulsory. Data normality testing was done, and the sign value of all the items was less than 0.05 in both the Kolmogorov–Smirnov and the Shapiro–Wilk tests, so the study used non-parametric tests for data analysis.

7.3.5.2 Reliability of the research instrument

Reliability testing was conducted to determine if the questionnaire survey constituted a reliable instrument for assessing the students' responses. All the items under the student survey were tested

using the Cronbach's alpha (α) measure. Although only a snippet of the items is represented in the table below, all items were tested and satisfied the requirements of Cronbach's alpha (α). According to the rule of thumb presented in Table 7.2, the lecturers' data had excellent internal reliability, with $\alpha > 0.9$ (table 7.6), and thus, is deemed reliable and consistent in gathering data.

Table 7. 6 Reliability Statistics

Cronbach's Alpha	N of Items
.941	485

Source: Primary Data, 2021

7.3.5.3 Snippet of detailed results

The reliability test of item-total statistics achieved an alpha (α) of more than 0.9, which is an excellent outcome on all items in the questionnaire. The study took only a snippet in Table 8 (see Appendix 4) of the first items since all items could not be presented. A total number of 484 items were tested.

7.3.5.4 Determining the correlation of variables

This was accomplished by using Spearman's correlation coefficient for the bivariate analysis that sought to find the relationship between age, gender and area of specialisation and SNS subscription; the other test, the Kruskal–Wallis test, was executed to verify whether or not specialisation or area of study affected the SNSs. The main thrust was to ascertain if the three factors affected the SNS subscription of lecturers. The first study analysed each of the three selected variables against the SNS membership variable, and the study, as seen in Table 9 (see Appendix 4), found that there was no relationship between lecturers' SNS membership and the three demographic variables age (0.092), gender (-0.031), and area of specialisation (0.060), guided by the rule of thumb described in Section 7.2.5.4.

The other test utilised one of the three variables, the area of study, to determine if SNS subscription is affected by the lecturer's field of study. The Kruskal–Wallis test presented in table 7.7 below also shows that SNSs are not in any way related to the area of study, and the different specialisation area groups have no significant impact (0.422, which is >0.05), and thus, the study automatically qualifies to be undertaken, irrespective of the area of study.

Table 7. 7: Kruskal–Wallis test

	SNSsMEMBER
Chi-Square	4.954
Df	5
Asymp. Sig.	.422

Source: Primary Data, 2021

7.3.5.5 Factor analysis

Factor analysis was executed on characteristics, features and uses to classify the 23 items into a manageable number of components. The KMO and Bartlett's tests were administered to test if the data were fit to be considered for factor analysis. The results in Table 7.8 show that the data were fit to be factored with a p=0.000 and X^2=4000.929 on Bartlett's test and a KMO of 0.951, which was greater than the minimum value of 0.5.

Table 7. 8: KMO and Bartlett's tests

KMO and Bartlett's Test		
Kaiser–Meyer–Olkin Measure of Sampling Adequacy.		.937
Bartlett's Test of Sphericity	Approx. Chi-Square	4000.929
	Df	253
	Sig.	.000

Source: Primary Data, 2021

From the 23 components, three components scored an Eigenvalue of one (1) and above. From those three components emerged 67.824% in square loadings, which is above half of the total variance. These three components indicated that characteristics, features and uses could be grouped into three categories, where the individual factors would fall according to the type of an item. The first component reached a very high Eigenvalue of 12.518, the second component had 1.833, and the third component had 1.018, Table 10 (see Appendix 4).

The study further conducted a factor rotation using the Varimax method to assess the strength of the correlation among the items under analysis, and each component was loaded with items with a strong correlation strength. Items falling under more than one group were deleted from the group loaded with a weaker coefficient. The first component with an Eigenvalue of 12.518, was loaded with nine items with the higher correlation values against them; the second component with an Eigenvalue of 1.833, was automatically loaded with eight items and their coefficient were stronger therefore were in an acceptable state and the third component with an Eigenvalue of 1.018, had loadings of six items from a total of 23 items, Table 11 (see Appendix 4).

7.3.5.6 Hypothesis testing

Hypothesis testing was conducted on the lecturers' three independent variables, age, gender and area of specialisation, against the dependent variable of SNSs subscription to test if these independent variables had an effect on subscription to SNSs in tertiary institutions, according to the lecturers' data. Hypothesis testing was done using the Kruskal–Wallis test (table 7.9), and the assumptions were declared in Section 7.3.1.1 where:

Age $\mathbf{H_0}$: University lecturer's age has no effect on SNS subscription.

Area of Study $\mathbf{H_0}$: Lecturer's area of study has no effect on SNS subscription

Gender **H_0**: Lecturer's gender has no effect on SNS subscription

Table 7. 9: Kruskal–Wallis Test

Grouping variables	Age	Gender	Area of Specialisation
Chi-Square	4.690	3.065	4.954
Df	2	2	5
Asymp. Sig.	.096	.216	.422

From the Kruskal–Wallis test, the asymptotic significance of age was 0.096, gender was 0.216, and the area of specialisation was 0.422, which is greater than 0.05. Thus, the study failed to reject the null hypothesis, which states that age, gender and area of specialisation have no effect on SNS subscription in university institutions.

7.4 Administrators' data

The administrators also use the framework to ensure that students are registered for the right course; in addition, they would usually convey information to students and even lecturers. The timetables of the virtual courses and synchronous lectures are prepared and distributed by the administrators. All the notices on the registration periods, payment of school fees, and even examinations and results are distributed by the administrators (Abed, 2019; Khan, 2010; Kituyi & Tusubira, 2013; Zanamwe, 2010).

7.4.1 Demographic data presentation of administrator respondents and student response rate

This section presents the ages, gender, marital status, degree status and area of study to gain general knowledge of the research respondents. The response rate enabled us to ascertain if the sample size was sufficiently representative of the population.

7.4.1.1 Demographic data presentation of administrator respondents

As mentioned in Section 7.2.1, technology-enhanced tools are usually embraced by a particular age group, whether or not they are academics (Cachia, 2008; Christofides et al., 2010; Holland, 2017; Musungwini et al., 2016; Zanamwe, Rupere, Kufandirimbwa, et al., 2013). Therefore, the study wanted to obtain clarification of the claim regarding the administrators. It was also assumed that the different areas of specialisation affected how administrators wanted to embrace technology; to wit, some still wanted to see a lot of paperwork to be convinced that the work had been done.

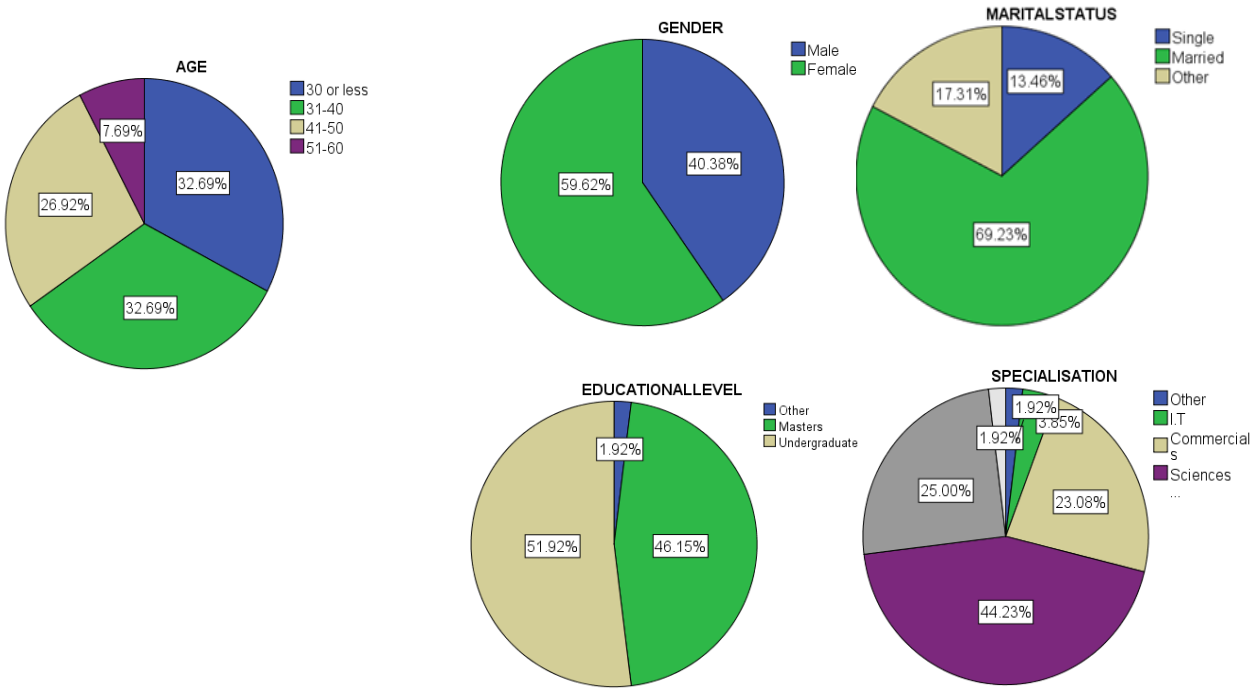


Figure 7.36: Demographics (Age, gender, education level and specialisation)

As shown in Figure 7.36, the majority of respondents were female (59.6 %) of the respondents, while males accounted for 40.4%. The results confirm that administrative work in universities in Zimbabwe is dominated by women. Interestingly, respondents who were 30 years old and younger shared the same percentage of 32.7 %, with respondents of 31–40 years old, which was the highest percentage, followed by 41–50 year-olds, with a percentage of 27.9%. More than half of the administrators were married (69.2%), 13.5% were single and other (17.3 %). Fifty-one point nine per cent of the administrators held an undergraduate degree, with (47.2 %) holding a Master's degree, while 1.9 % had attained other qualifications. The sciences were represented by 44.2 %, the arts by 25%, commerce by 23.1%, IT by 3.8%, education by 1.9 %, and other by 1.9 %.

7.4.1.2 Response rate

We sent 52 questionnaires to administrators' and all were returned, providing a response rate of 100%, which is good and, therefore, the validity of the data was not compromised since validity depends on the response rate, Morton et al., 2012 in (Mahlangu, 2020).

7.4.2 Social networking site types, usages and benefits.

The administrators were asked about the benefits of SNSs according to how they use social networks; this information was deemed imported since users of the system would already be equipped with the knowledge of the benefits they could reap from using the FSNS. The main uses expected from the pool of SNS uses and applied by the FSN to the administrators' side would have had something to do with communication, although they were asked about the general uses of SNSs.

7.4.2.1 SNS use

The study sought to analyse the number of SNS users and intended to ascertain if the users were indeed using these SNSs. Since our main objectives were the development of an FSNS, the research required users of SNSs to participate, figure 7.37.

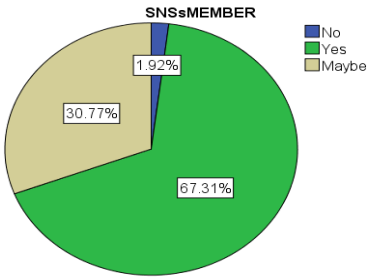


Figure 7.37: SNS use

Of 52 administrators, 35 agreed that they habitually used SNSs, while 16 expressed that they were unsure, and one administrator claimed they did not use SNSs at all, amounting to 98.07% of SNS users of all respondents. This analysis assured us that the questions answered with the condition that a subscriber used the SNSs were well represented. On the SNSs the administrators used (Figure 7.38), most respondents voted for WhatsApp (41, 40.4%), Facebook (38,37.9%) and Twitter (20, 24.4%). The rest, for example, MySpace, LinkedIn, Sasai, Instagram, YouTube, WeChat, Messenger, TikTok, Telegram, Pinterest and SnapChat received very few votes.

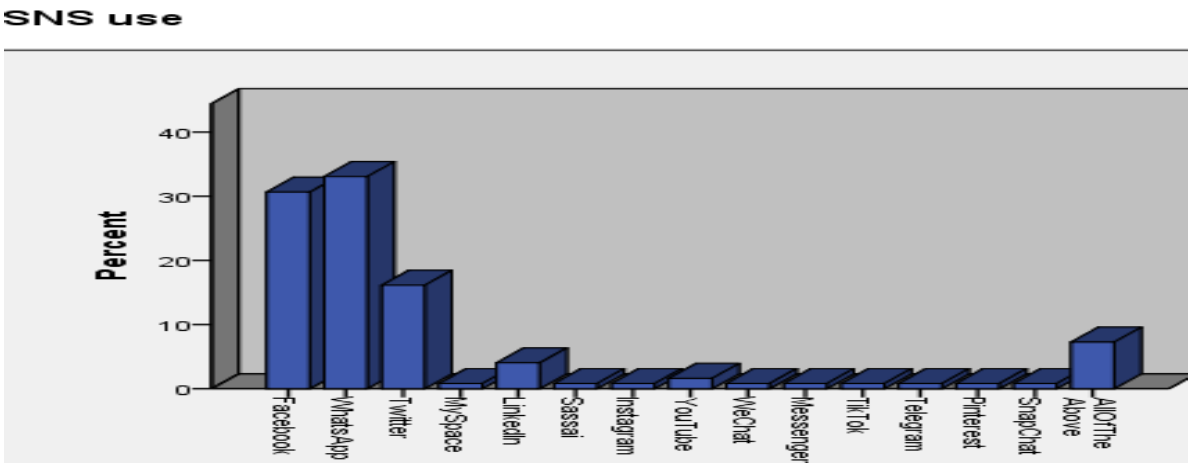


Figure 7.38: SNSs subscribers

7.4.2.2: SNSs subscribed to by each administrator

The survey also assessed the number of SNSs subscribed to by each administrator (see Figure 7.39). This information was crucial to obtaining an overview of the number of SNSs to be included in the federated networking sites. The highest number of SNSs subscribed to by our respondents was 14, with one respondent, followed by five accounts being subscribed to by one respondent, and four SNSs with a subscription of one respondent. From my sample, the highest number of respondents (21) indicated they were subscribed to two SNSs—this trend reveals that most administrators are not subscribed to many SNSs, as shown by Figure 7.39, where 16 subscribers were subscribed to a maximum of three SNS and 11 respondents were subscribed to all SNSs.

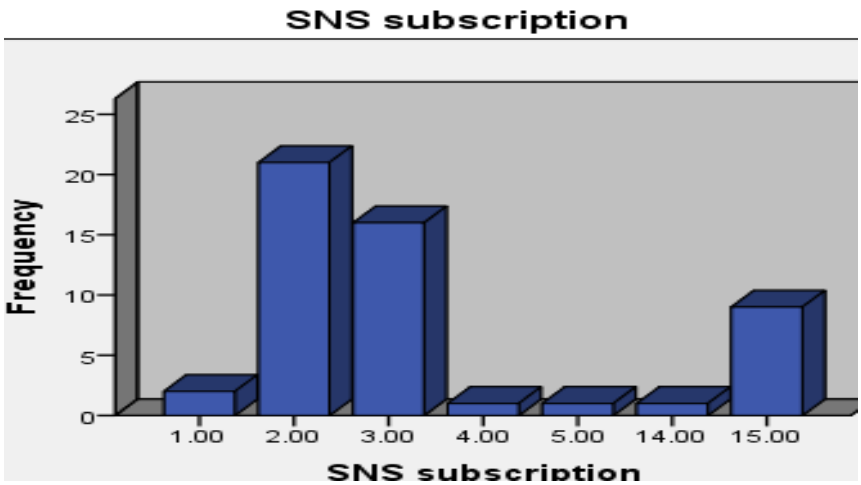


Figure 7.39: SNSs subscribed to per student

7.4.2.3 Frequency of SNS use

The study sought to analyse the usage patterns of the administrators. This information is required since the FSNS is expected to be used daily, which means SNSs should be integral to their daily activities for them to embrace the FSNS tool.

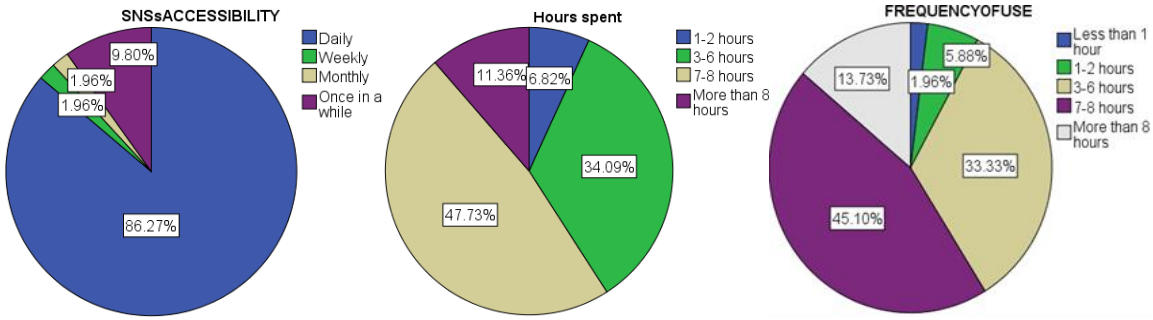


Figure 7.40: Frequency of use and hours spent

Figure 7.40 above shows that the SNSs are visited by administrators occasionally, with 86.3% of the respondents using SNSs daily and 100 % of them spending at least an hour on SNSs (see hours spent chart). Nine point eight per cent of respondents indicated that they occasionally visited SNSs, and 1.9% of those who used SNSs indicated that they only used it for less than an hour. These results show that administrators are on SNSs regularly, which means it would be very easy for them to switch from their personal business to work, which means they would be working in the same environment as that of their personal business.

7.4.2.4. Internet access

Most respondents had embraced internet life, as highlighted by the highest percentage (63.8%) of respondents indicating that they moved around with their internet, i.e., anything related to the internet could be done anywhere and at any time, figure 7.41. The second largest group (18.8%) stated that they

accessed the internet at their workplaces, while 15.9% indicated that they accessed the internet at home, and only 1.4% went to an internet café to access the internet.

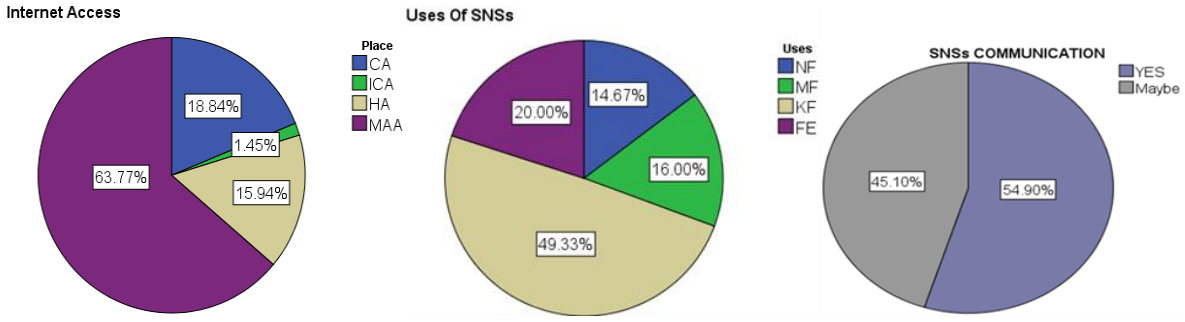


Figure 7.41: Internet accessibility, uses of SNSs and communication via SNSs

7.4.2.5 Reasons why university administrators use SNS

The study wanted to uncover the respondents' reasons for using SNSs. Although there are many reasons, Figure 7.41 displays the main reasons, namely general and academic reasons. General reasons for using SNSs were indicated by most of the respondents (37) as needing to stay in touch with family and friends, followed by fun and entertainment (15), whereas maintaining existing friends and making new friends were indicated by 12 and 11 respondents, respectively.

7.4.2.6 Communication

This section sought to ascertain if the university was proactively communicating with students via social networking sites. The response is depicted in Figure 7.41, with 55% stating the university used SNSs; neutral scored 45 %, although in this case study, maybe (neutral) as a response was included in the same criteria as the yes response.

7.4.2.7 Mostly used by universities

According to figure 7.42 most often used SNSs by the university for communication were Facebook with 51 (41.5%), WhatsApp, 49 (40%), and Twitter with 36 (29.3%). Interestingly, 12 (9.8%) administrators indicated all social networks as SNSs used by the university for communication purposes. This indicates that communication is concentrated on WhatsApp, Facebook and Twitter only, and other platforms are not frequently used.[15]

[15] **The figures given in the description of the results include the 12 (9.8) % who indicated all SNSs are used by universities**

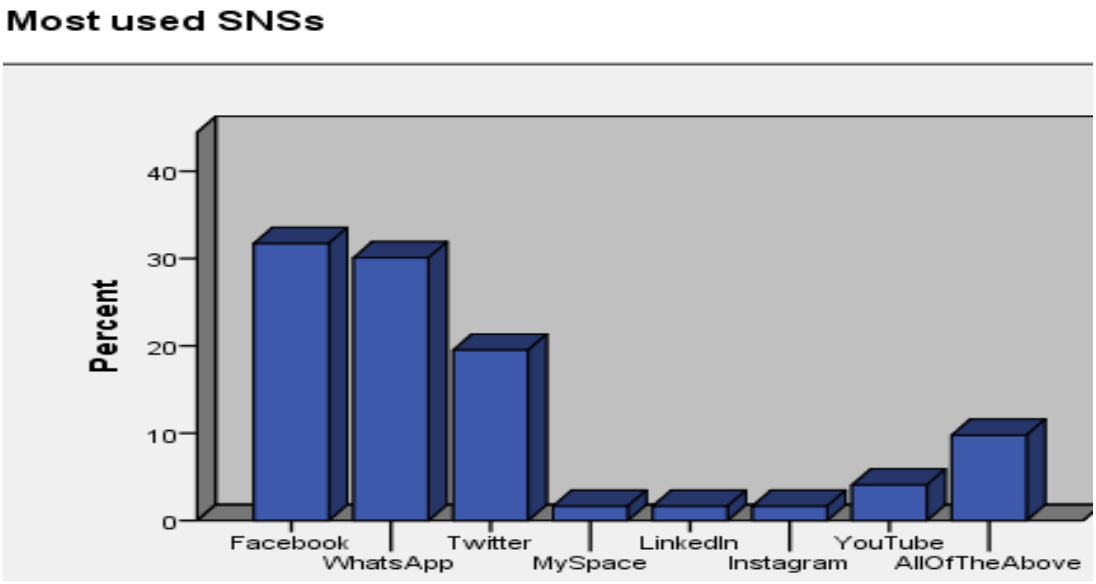


Figure 7.42: SNSs used for communication by the university

7.4.2.5 Uses of SNSs by universities

Figure 7.43 discusses the uses of SNSs where administrators indicated that the university uses SNSs to post announcements (63.4%) and to receive feedback from its stakeholders (34.6%).

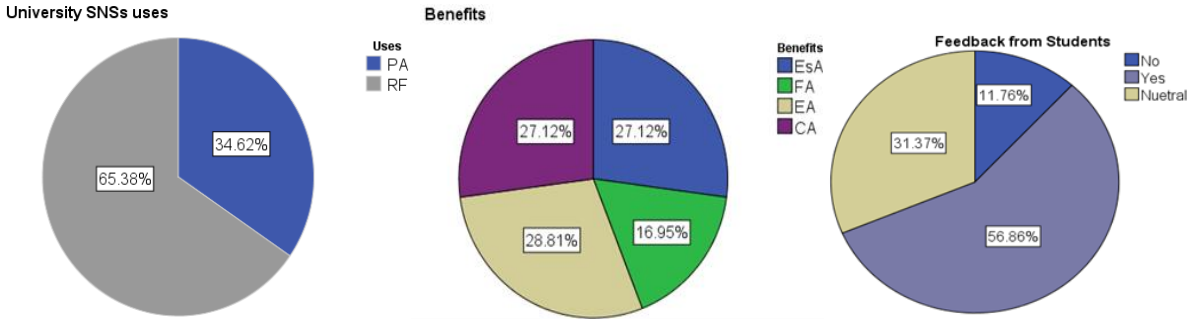


Figure 7.43: SNS uses, benefits and feedback from students

7.4.2.6 Benefits of SNS according to administrators

The administrators cited the following benefits when universities use SNSs to enhance eLearning processes: ease of the conveyance of messages (17), facilitates easy two-way communication between administrators and students (10), everyone is subscribed to at least one social networking platform to guarantee messages reach the intended recipients (117), and it is a cheaper means of communicating (16). (see Figure 7.42 for information on the percentages.)

7.4.2.7 Feedback from students

Figure 7.43 exhibits that some (56.9%) of students provide feedback through SNSs; (31.4%) responded that if probed, would only answer what they had been asked about, and (11.8%) did not even bother to respond.

7.4.3 Similarities and differences between the social networking platforms

This section of the study discusses the questionnaires designed for the lecturers' responses to shed light on the similarities and differences between the SNSs under study. The items listed on the answer grid are characteristics, features and uses of the SNSs, as explained in Chapters 2 and 3, where some of the literature consulted include Alassiri et al. (2014, Bonds-Raacke and Raacke (2010), Branden et al. (2011) Braun et al. (2017), Cachia (2008), Munene and Nyaribo (2013) and Sungkur and Rungen (2014). From Table A12 (see Appendix 4), 23 characteristics/features/uses were listed for the administrators for them to provide their points of view. From their responses, WhatsApp and Facebook share a lot of common characteristics/features/uses since they each have high numbers of votes on all characteristics/features/uses listed; for example, on dissemination of information, Facebook garnered a total of 44 votes and WhatsApp a total of 35 votes, meaning Facebook and WhatsApp both possessed the dissemination of information feature and, therefore, are similar in that aspect, without that feature the SNSs are different regarding that element. The table shows that most of the SNSs do not possess the characteristics/features/uses as displayed by the results in Table A12 (see Appendix 4).

7.4.4 How federated SNSs can be used as an eLearning tool

The administrators would communicate with students and lecturers using the FSN; hence this study should enquire if they had been using any eLearning tool, which provides the study with knowledge about the users the framework is being developed for and whether they need training or are already literate.

7.4.4.1 SNSs to be incorporated in federated SNSs

Figure 7.44 below presents the SNSs to be included in the federated SNS. Although WhatsApp (50, 47.7%), Facebook (49, 47.7%) and Twitter (45, 42.9%) garnered the largest number of respondents, a considerable number of administrators vouched for all SNSs to be included in the FSNS. This might be because inclusion would inspire users to utilise and experience its features and uses.[16]

[16] **The figures given in the description of the results include the 28 who indicated all SNSs should be included.**

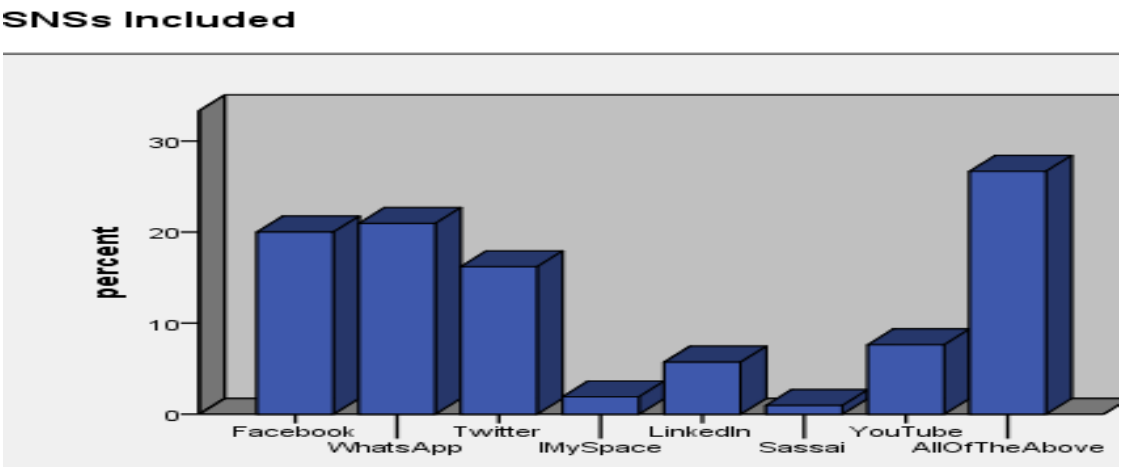


Figure 7.44: Services to be included in SNSs

7.4.4.2 Services

The study summarised the findings from the extant literature into 14 services offered by SNSs. From these, the respondents were asked to choose the services that should be included in the FSN. Figure 7.45 below suggests that all services should be offered, considering that all services obtained 47 (67.1%) out of 52 votes.

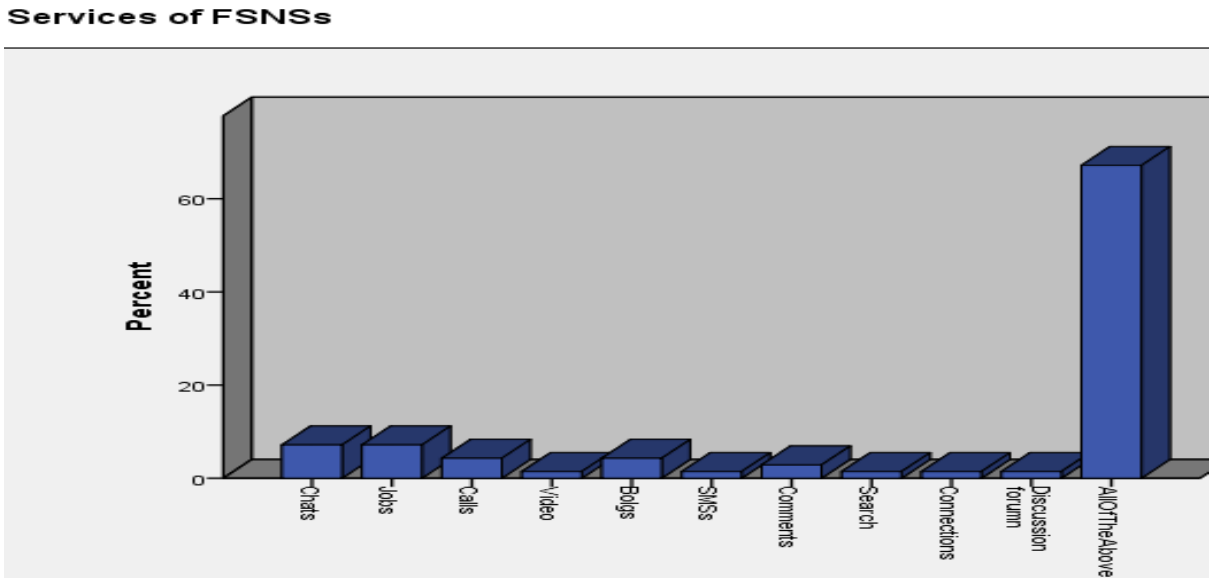


Figure 7.45: Services offered by SNSs

7.4.4.3 Characteristics, features and uses

The FSNS to be developed should be identified by certain characteristics, features and uses, in light of Table A12 (see Appendix 4) that detailed the similarities and differences between SNSs (Figure 7.46). Respondents were asked to choose all the characteristics, features and uses they deemed fit to shape the proposed FSNS. According to the listed features and uses, disseminating information (48, 5.9%), research (48, 5.9%), and encouraged interactivity in both peer and academic support (48, 5.9%) garnered the same number of votes, while 44 (64.7%) administrators indicated that all the characteristics/features/uses should be included.

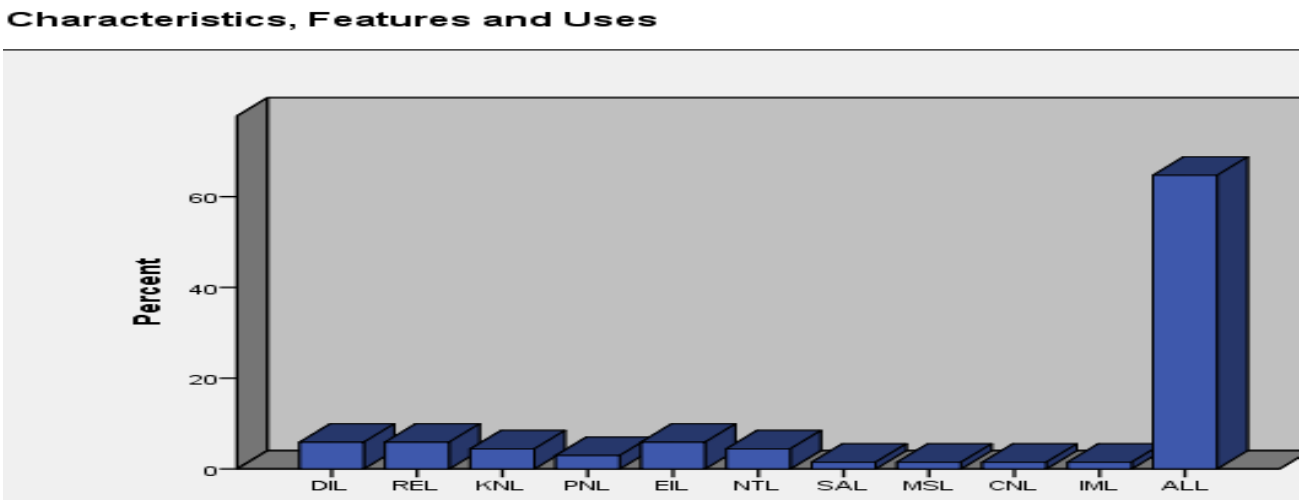


Figure 7.46: Characteristics, features and uses

7.4.4.4 eLearning model and its purposes (uses)

The administrators were requested to indicate the type of eLearning model they were currently using. Most of them (42) as indicated in figure 7.47, picked the general ICT model, and the remainder (10) the social networking-based model. From those eLearning models, the administrators stated some uses related to them: 15 respondents indicated feedback, divided into the general ICT-based model (10) and the social networking-based model (5), and notices platform (42), divided into the general ICT-based model (36) and social networking-based model (6).

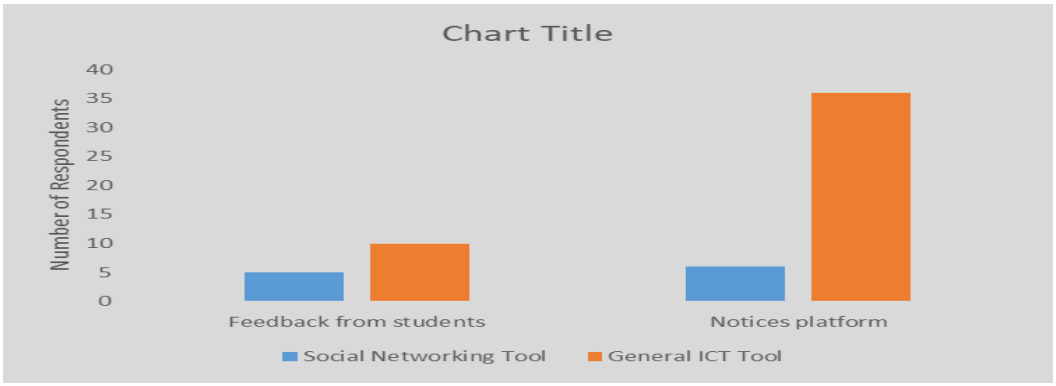


Figure 7.47: Benefits of eLearning model

7.4.4.5 Compulsory use of eLearning at the university

Nineteen of 52 administrators indicated that using the eLearning model was compulsory at the university, while nine denied that, and 24 were unsure (see Figure 7.48). This confirms that the university has embraced the eLearning facility, which allowed the study to introduce an FSNS as an eLearning tool, noting that there would be very little resistance to change since the participants had been using it in some way, and by assisting the lecturers and students with using the platform.

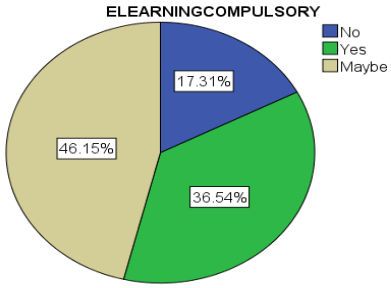


Figure 7.48: Compulsory use of eLearning

7.4.5 Preparing data for statistical analysis

This preparation was necessary to ensure the data was suitable for statistical analysis and also to select the appropriate statistical tools for analysis.

7.4.5.1 Missing values and outliers and normality testing

Missing values of data were dealt with during the design of the questionnaires, where compulsory questions were indicated. Data normality testing was done, and all the items' sign value was less than 0.05, both in the Kolmogorov–Smirnov and Shapiro–Wilk tests. Accordingly, the study used non-parametric tests for data analysis.

7.4.5.2 Reliability of the research instrument

According to the rule of thumb presented in Table 7.10, the administrators' data had a good internal reliability of 0.856, and consequently, the data-gathering was deemed reliable.

Table 7. 10 Reliability Statistics

Cronbach's alpha	n of Items
.856	456

Source: Primary Data, 2021

7.4.5.3 Snippet of detailed results

The reliability test of the item-total statistics obtained an alpha of more than 0.8, which is a good alpha quantification on all items in the questionnaire. Table 13 contains a sample of the first item since all items could not be presented (see Appendix 4). A total number of 484 items were tested.

7.4.5.4 Determining the correlation of variables

This analysis was executed using Spearman's correlation coefficient for the bivariate analysis that sought to find the relationship between age, gender and area of specialisation and SNSs membership; the Kruskal–Wallis test was done to verify whether or not specialisation affected the SNSs. The main thrust was to ascertain if those three factors affected the administrators' SNS subscriptions. The first

study analysed each of the three selected variables against the SNS membership variable, and the study, as seen in Table 7.11below, displays no or little relationship between the administrators' SNS subscriptions and the three demographic variables, i.e., age (-0.061), gender (-0.312*), which is a low negative correlation, and area of specialisation (0.162), which is a negligible correlation, according to the rule of thumb presented in Section 7.2.5.4, Table 14 (see Appendix 4).

The other test investigated whether one of the three variables, the administrators' area of study, affected SNS membership. The Kruskal–Wallis test presented below also shows that the SNSs were not in any way related to the area of specialisation, and the different specialisation area groups had no significant impact (0.159, which is >0.05). Therefore, the study automatically qualified to be undertaken, irrespective of the area of specialisation.

Table 7. 11: Kruskal–Wallis test

	SNSsMEMBER
Chi-Square	7.951
Df	5
Asymp. Sig.	.159

Source: Primary Data, 2021

7.4.5.5 Factor analysis

Factor analysis could not be conducted on the characteristics, features and uses of the 23 items of the administrators' data with 52 participants; accordingly, the following warning was heeded: "[If] there are fewer than two cases, at least one of the variables has zero variance, there is only one variable in the analysis, or correlation coefficients could not be computed for all pairs of variables. No further statistics will be computed" Source: Primary Data, 2021.

7.4.5.6 Hypothesis testing

Hypothesis testing was administered on the administrators' three independent variables, i.e., age, gender and area of specialisation against the dependent variable of SNS subscription, to test if these independent variables had an effect on the subscription of SNSs in tertiary institutions according to the administrators' data. Hypothesis testing was done using the Kruskal–Wallis test. The assumptions declared in Section 7.4.1.1 where:

Age $\mathbf{H_0}$: University administrators' age has no effect on SNS subscription.

Area of Study $\mathbf{H_0}$: Administrators' area of study has no effect on SNS subscription

Gender $\mathbf{H_0}$: Administrators' gender has no effect on SNS subscription

Table 7. 12: Kruskal–Wallis test

	Age	Gender	Area of Specialisation
Chi-Square	2.978	4.963	7.951
Df	2	1	5
Asymp. Sig.	.226	.026	.159

a. Kruskal–Wallis test

b. Grouping Variable: age, gender and area of specialisation

Source: Primary Data, 2021

From the Kruskal–Wallis test table 7.12, the asymptotic significance of age is 0.226, and the asymptotic significance of area of specialisation was 0.159, which was greater than 0.05. Accordingly, the study failed to reject the null hypothesis, which states that age and area of specialisation have no effect on SNS subscription in university institutions. In contrast, the asymptotic significance of gender was 0.026, which was less than 0.05; thus, we rejected the null hypothesis, which states that gender has no effect on SNSs subscription.

7.5 Combining the results

The study analysed the combined demographic profiles, SNS usage, SNSs to be included in the FSN, services of the FSN and the features/characteristics/uses of FNS by all three groups, namely students, lecturers and administrators.

7.5.1 Demographic profiles

Table 15 (see Appendix 4), shows that participants from education studies were generally few across the three groups, while commercial studies were generally many. Regarding gender, whether working or learning, male participants were dominant, except for the administrators, which indicated that girls should be promoted and encouraged to learn and work by taking measures again child marriages (Dzimiri, Chikunda and Ingwani, 2017; Efevbera and Bhabha, 2020; Bengesai, Amusa and Makonye, 2021). In addition, by encouraging married women to work rather than becoming housewives and shelving their certificates. The results on marital status showed that most students were not yet married, and judging by the ages of the majority of respondents of 22 or less (49.4%), most students would rather build their careers before considering marriage.

7.5.2 SNSs usage

All three groups in Table 16 (see Appendix 4) reflect that more than 60 % of respondents stated that they used SNSs, and more than 80% in all the groups indicated that they used SNSs daily. This encouraged us to consider the development of the proposed FSNS since participants directly linked to teaching and learning were involved with SNSs, which we were contemplating developing into an eLearning tool.

7.5.3 SNSs to be included in the FSNS

The study sought to identify the SNSs the respondents wanted to be included in the proposed FSNS. The results in figure 7.49 shows that WhatsApp was the top-voted SNS, Facebook also had a high percentage of voters, and YouTube, Twitter and LinkedIn attained higher percentages than the other SNSs not mentioned. Only the administrator group voted highly (27.7%) for all the SNSs to be included.

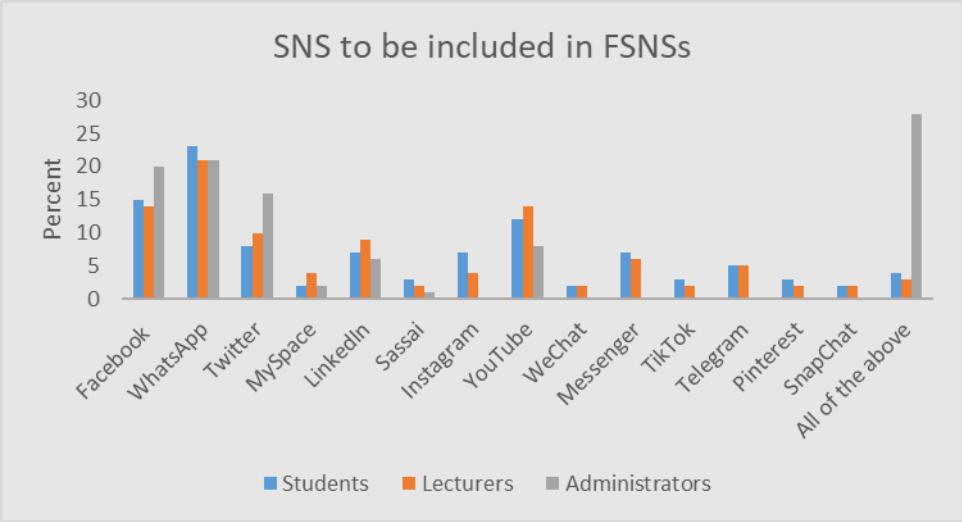


Figure 7.49: SNSs to be included in the FSNS

7.5.4 Services to be included in the FSNS

As regards services to be included figure 7.50, the students and administrators agreed that the proposed FSNS should possess all the services mentioned, although the lecturers had mixed feelings, as witnessed by the distribution of votes, where the highest percentage was 9.6% and the lowest, 3.1%.

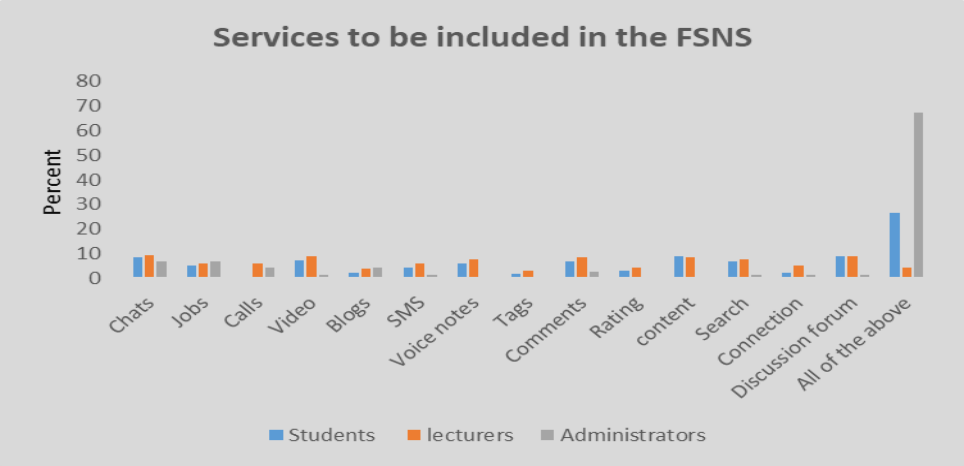


Figure 7.50: Services to be included

7.5.5 Features, uses and characteristics

The students and lecturers distributed their votes among the given items, even though the top most selected items were channels of communication, knowledge exchange, and research and dissemination of information, the administrators believed that all the items should be included, as demonstrated by 64.7% of votes for such inclusion, this data is presented in figure 7.51.

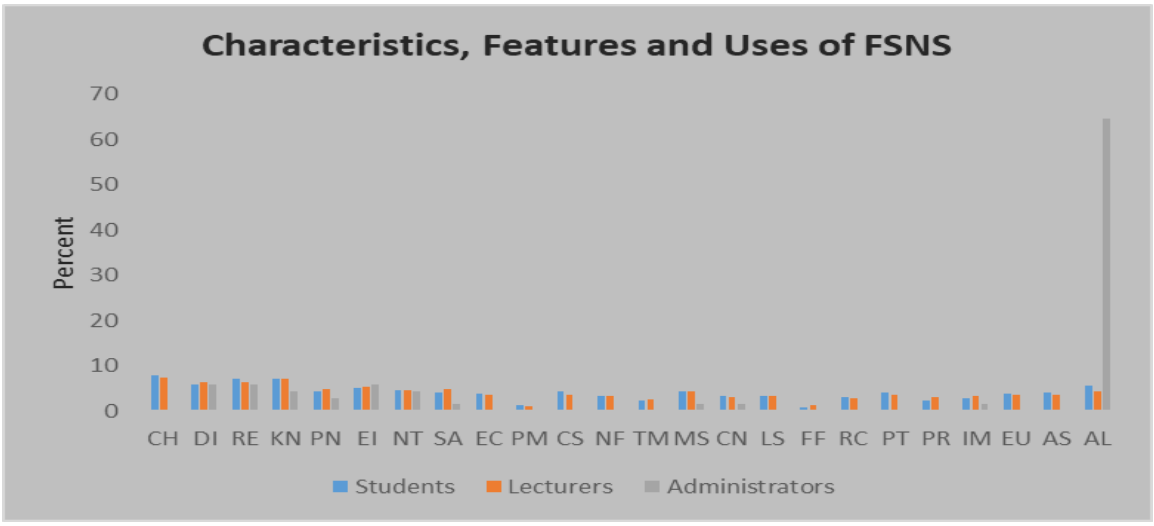


Figure 7.51: Features, uses and characteristics

7.5.6 Mean of the SNSs to be included in the FSNS

From the SNSs to be included in Table 16 (see Appendix 4), the study analysed the mean number of the SNSs. This was done by finding the frequency number of SNSs voted for by each individual; for example, one respondent would vote for all SNSs to be included, the other voted for two, the other six, and so forth. These frequencies determined the mean number of SNSs to be included in the proposed FSNS. The mean of the three groups ranges from 4.6 to 9.4; hence we calculated the overall mean, which attained 7.45, leading to the conclusion that seven SNSs would be included in the FSNS to be developed. The standard deviation of the three groups was not high, considering the ranges of 14 across all groups.

7.5.7 Mean of services to be included in the FSNS

Although the mean of the services to be included differed in each group, the margin was small: the students' mean was 11, the lecturers' mean was 10 and the administrators' was 14. From those means, we deduced the overall mean of 12. These would be identified by the common votes from all three groups. The standard deviation of all the groups was favourable, considering the ranges of 14 in two groups and 12 in the other group. Table 17 (see Appendix 4).

7.5.8 Features, uses and characteristics

From the table that analysed the number of features, uses and characteristics, the administrators' largest number indicated that all features should be included, although the same was not true from the lecturers' and students' results, with more than 30% agreeing that all should be included. All 23 items were included, and factor analysis was used to group the features, uses and characteristics listed to be included in the FSNS according to the group they belong to. Three groups were identified, as shown in Table 18 (see Appendix 4). Component 1 contains 13 items from the 23 features, uses and characteristics listed; Component 2 contains seven items for the FSNS; and Component 3 has three items. From the students' and Lecturers' factor analysis Table 6 (Appendix 4) and table 11 (Appendix 4), three components were identified where the 1st component was loaded with 14 and 9 items, 2nd component was loaded with 6 and 8 items whilst the 3rd component was loaded with 3 and 6 items respectively. The loadings were slightly different in the sense that although we had three components represented, some items fell into different loadings for example the item on *Enhanced the construction of students' own learning and the continuation of their engagement in development (ECL)*loaded on student's data on component 1 with a 0.698 and on lecturer' data was 0.570 on component two. So the final component to be represented was chosen to be the one with the strongest correlation, and ECL was therefore loaded on the 1st component category.

7.5.9 Diagrammatical representation of the components from the factor analysis.

From the factor analyses combined, three components were derived to group the 23 items from the features, uses and characteristics analysis. From the way these components were grouped, the study assigned the most appropriate name to each group. The first component with 13 items was labelled "features and uses", the second component with seven items was labelled "characteristics", and the last component with three items was labelled "updates". Figure 7.52 below demonstrates how 23 items feed into three components, and these components feed into the FSNS.

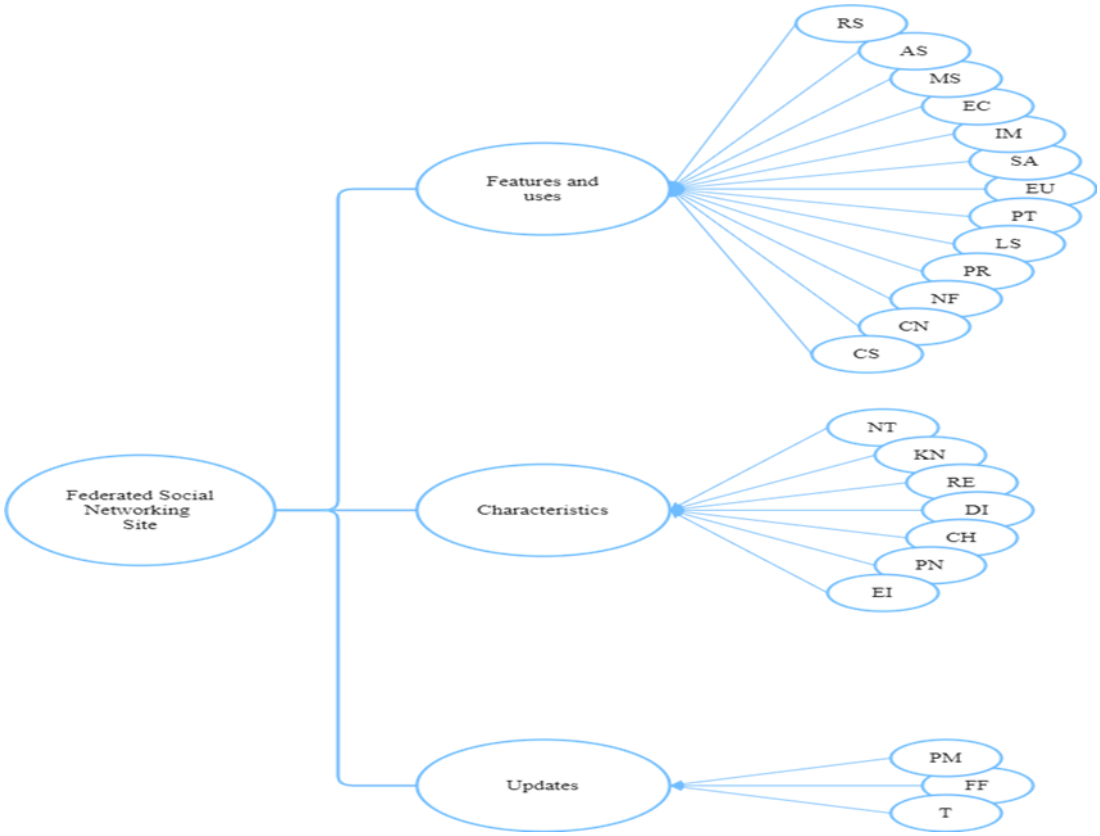


Figure 7.52: Diagrammatical representation of the components from the factor analysis

7.10 Summary

Chapter 7 presented the data collected from students, lecturers and administrators using a qualitative collection method. The chapter presented the demographic data, the response rate from each group and the reliability tests undertaken. Statistical tests included the Kolmogorov–Smirnov and Shapiro–Wilk tests, the Kaiser–Meyer–Olkin (KMO) test, Barlett's test of sphericity, Cronbach's alpha reliability test, factor analysis and hypothesis testing on the factors affecting SNS subscription. The combined analysis of data from students, lecturers and administrators was conducted, and the average mean of the number of SNSs and features to be included from all three groups.

Chapter 7 described the second step towards fulfilling SRO4: *To evaluate and validate the proposed conceptual FSNS4eL and then deliver an improved version for further adoption*. From the data presented and analysed, the objective at hand will be met in Chapter 8, considering that Chapter 6 has laid a strong foundation and Chapter 7 did a thorough data analysis that contributed immensely to the improvement of the FSNS4eL. The next chapter examines the presentation of the expert data and presents a discussion of all the collected data, intending to achieve the study objective and comprehensively answer SRQ4: *How can federated SNSs be validated and improved to obtain an improved version that can be used as an eLearning tool in universities?*

Chapter 8 : An Improved Framework for Federated Social Networking Sites for eLearning

8.1 Introduction

The proceeding Chapter detailed the analysis and results of the data quantitatively collected. Chapter 6 presented the data collection methodology in preparation for the analysis and results outlined in Chapter 7. These two chapters contributed towards the same objective that will be met in Chapter 8. This chapter presents the proposed conceptual framework after factoring in the contribution from the quantitative data analysis; thereafter, data from the framework validation template is presented, and the redesigned framework is presented after incorporating the feedback from the nine expert reviewers. This chapter aims to satisfy SRO4: *To evaluate and validate the proposed conceptual FSNS4eL and then deliver an improved version for further adoption*. SRO4 was first declared in Chapter 6, in which the first step taken towards achieving the objective is described; the second step taken is discussed in Chapter 7; and the last and final step taken is expounded on in the current chapter. The output of this chapter is an improved framework for FSNS4eL to be made available for adoption in higher and tertiary institutions.

This chapter starts with the eLearning case study, in which the presentation of a generic scenario of eLearning is presented. The following section presents the expert review in which the demographic data, feedback from validation, and the critical review of the feedback are discussed by determining the relevance of redesigning the framework. Once no more revision was required, we redesigned the framework.

The chapter also discusses the findings of the data presented in Chapter 7, encompassing the uses of SNSs, the benefits of utilising SNSs as an eLearning tool as well as its drawbacks. The parameters used by the experts are also discussed to ascertain whether they provided authentic feedback and compare it to other scholars who have used such parameters before. Thereafter, the study discusses the statistical analysis methods used in Chapter 7 and the ensuing results. Chapter 8 comprehensively and satisfactorily answers SRQ4: *How can federated SNSs be validated and improved to obtain an improved version that can be used as an eLearning tool in universities?*.

8.2 eLearning Generic Scenario Description

A typical eLearning system is a platform that enables administrators to log in and add modules offered that semester, post notices, and prepare timetables for lectures. The eLearning system should also allow lecturers to log in, add modules they teach that particular semester, upload and download material, and create links to lectures. The platform should allow students to register for the modules they are taking that semester, upload and download material, and create links to discussions. On the same platform, the user should be directed to all links and platforms containing the tasks they need to execute.

After a student is admitted to a university, they are allocated a student registration number which would be used to identify them in all the activities at the university. The modules for that semester must be registered for students to access learning material.

The administrator adds the modules being offered during a particular semester. If a semester is modularised, the administrator uploads the modules offered for that particular quarter. The

administrator assists with the timetable to be followed during the learning period; the timetable can be personalised by all students and lecturers to provide reminders on lecture times. Furthermore, the administrator can send notices to all students or particular students, depending on the nature of the notice.

The lecturer logs into the system and adds the modules they would be facilitating that particular learning period; the lecturer creates a link for students to join during lecture times and uploads the reading material and module outline for registered students to access. The lecturer can also create assignments and their deadlines; further, the lecture link can be embedded with the downloadable register to view the students who attended the lecture. Lastly, the lecturer can download the marks assigned to particular assignments and record each student's on the marks management system.

The student selects the modules they are doing that quarter and registers, after which the timetable and course content of their modules would appear on their portal. The student can download and upload learning material, send private or public comments for a particular module, post assignments and view their grades after assignments have been marked. For group collaborations, team members can send invitations for discussions prospective members can join and attend, recording each discussion and downloading the attendance register. For-text based discussions, students might form a group where they can discuss and keep or print their chats for future use. The student can send queries to the administrator or lecturer and receive feedback through the same platform, and view posted notices. The students can also evaluate the lecturer, with the evaluation going directly to the lecturer without the evaluator's credentials.

8.3 Expert review presentation

The experts were selected purposively (as discussed in Chapter 6), i.e., nine (9) specialists with at least five years' experience of working in the academic and IT fields. These experts were requested to analyse the output of the research independently using the FSNS framework to identify problems and provide corrective recommendations. A validation guide was provided for the experts to have a uniform interpretation of the attributes used in the validation template. In this section, the study presents the data gathered from the qualitative expert review.

8.3.1 Experts' demographic data

Of the experts, two of nine participants were women, meaning that seven participants were male, and most of these participants were from Zimbabwean universities. Most of the participants' highest qualifications were a doctoral degree (five of nine participants), while three of nine held a Master's degree, and only one expert had a BSc degree. Figure 8.1 presents the analyses and demographics of the experts, such as their designations or positions, whereby three of the nine participants were

Lecturers, two were ICT directors, one was a lecturer as well as the head of a department, and another expert held the position of a senior lecturer as well as that of ICT Director. As detailed in Figure 8.1, most of the experts' duties were teaching, researching and coordinating research, with one specifically indicating that they supervised postgraduate students. Some indicated they only supervised projects, and their other duties comprised curriculum review and innovation, while others were ICT directors in universities and responsible for leading, planning and managing ICT strategies, operations and infrastructure.

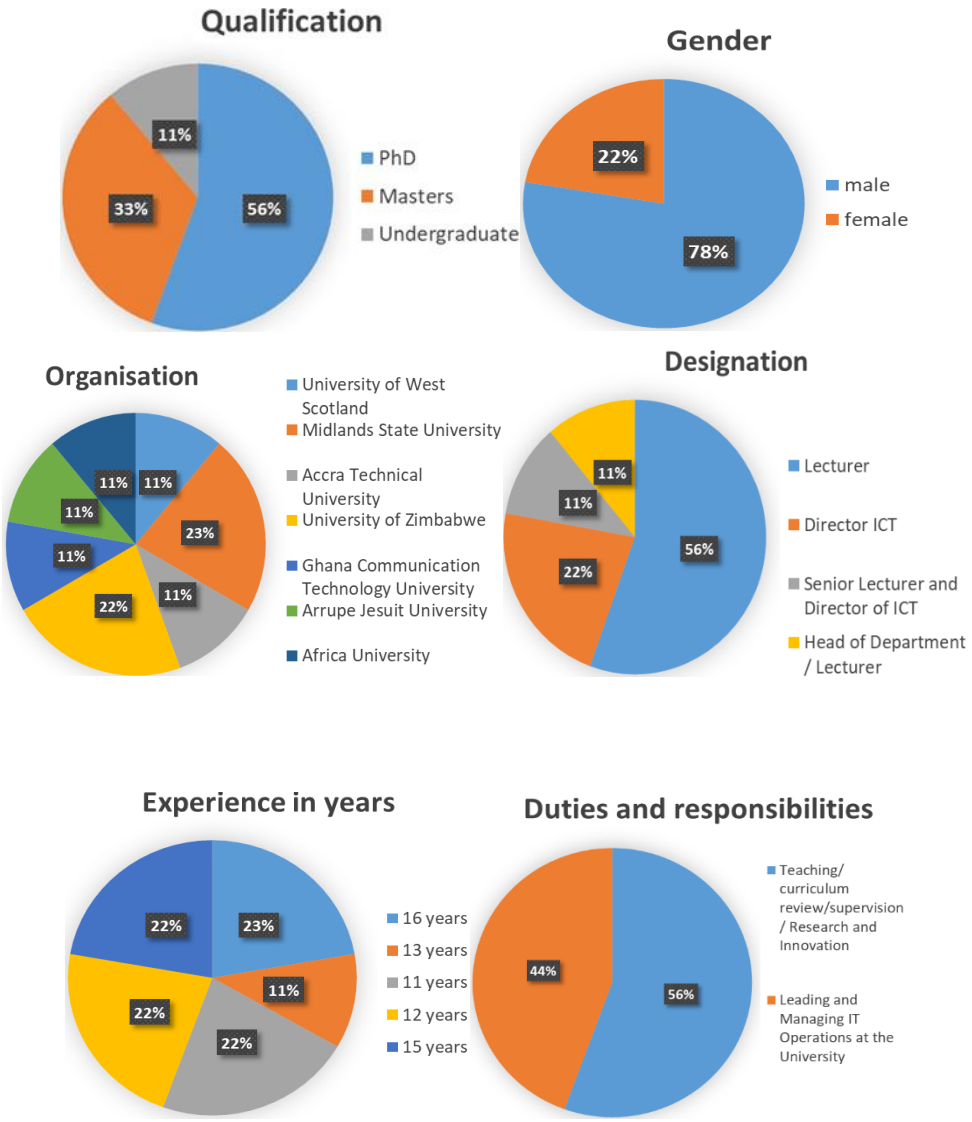


Figure 8.1: Demographic status of the experts (gender, organisation, highest qualification, designation and both or either position, duties and responsibilities and experience in tertiary institstutions)

8.3.2 Feedback from framework validation

The experts were expected to provide their responses from the review of the federation of SNSs as an eLearning tool among university students and the staff who were "directly linked" to them. The responses were presented according to the parameters defined for them to comment on; later, any

additions that were addressed would be presented**.** The study declared seven (7) quality parameters to guide the experts in reviewing and validating the conceptual framework presented after adjustments and a redesign after the quantitative data collection, which is described in Chapter 6. The clusters included in the participation were the students (316), lecturers (218) and administrators (52). The original conceptual framework was presented in Chapter 5 in Figure 5.20; Figure 8.2 below presents the redesigned conceptual framework after the data collection from the survey. The results from the survey contributed other components to improve the framework, before it was sent for validation. Three components from the factor analysis were added, namely features and uses, updates and characteristics. These were added as activities that are needed by the FSNSs to function properly and they were borrowed from the source SNSs.

A security layer was added, considering that Students expressed concern on the security of their data and one advantage which is repeatedly mentioned in different types of FSNSs discussed in chapter 2(Narayanan *et al.*, 2012; Cabello, Franco and Alexandra, 2013; Silva *et al.*, 2017). The security layer is expected to implement such security measures as firewalls and end-to-end encryption.

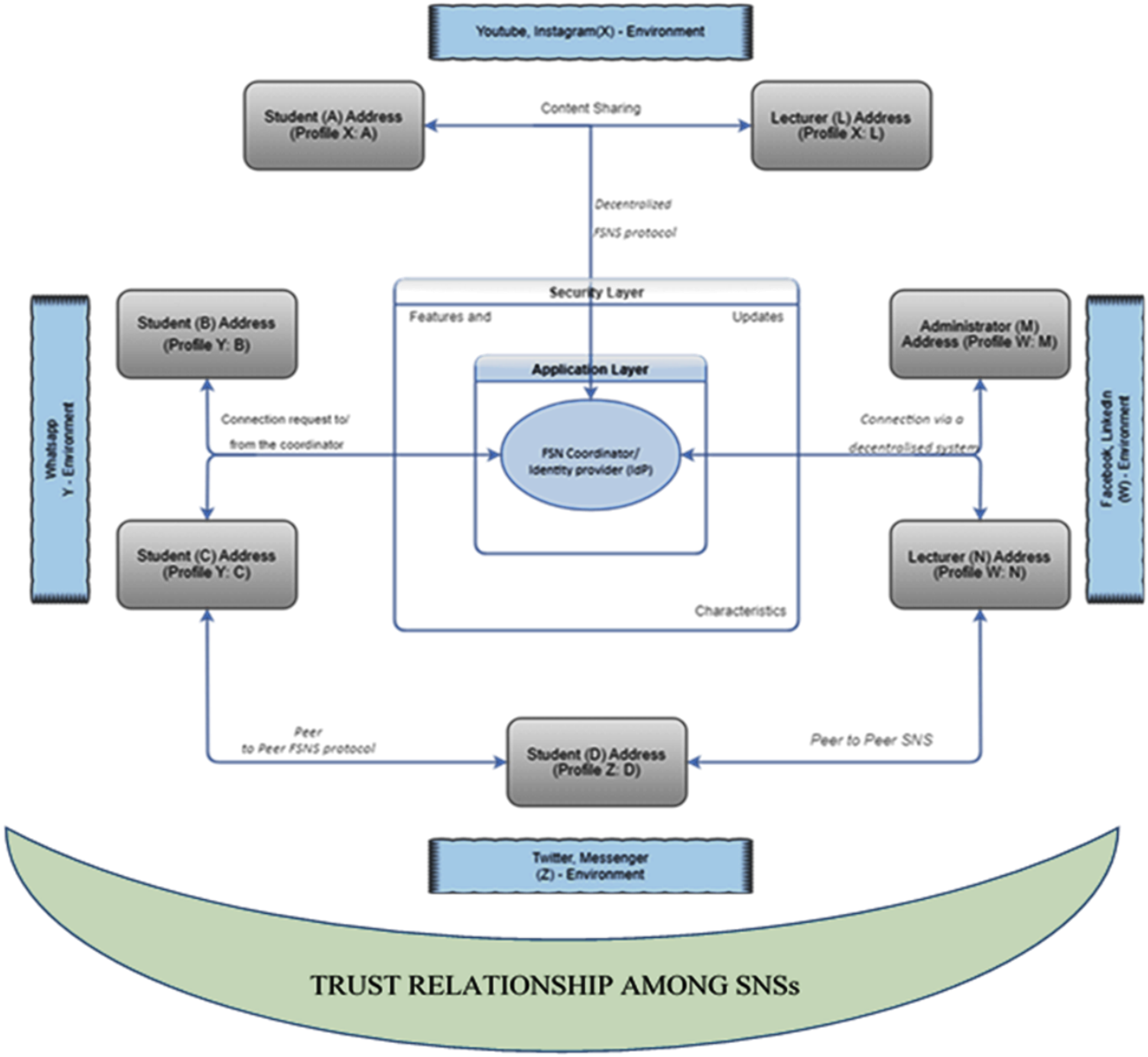


Figure 8.2: Redesigned hybrid FSNS

8.4 Explanation of the framework

In this framework, some requests and transmissions go through a coordination model that handles any routing from one SNS to another and even within. The FSNS coordinator can plug into any SNS and vice versa and easily register a user in any other SNS for transmitting messages when necessary. However, each SNS maintains its own integrity yet has the ability to pass messages to other SNSs. The framework is a combination of peer-to-peer and client-to-server frameworks; when communication involves fewer users, the peer-to-peer takes over, while during communication among many users with different SNSs, the client-to-server aspect is used. For example, in the client-to-server framework, an administrator (M) registered to social networking sites like Facebook or LinkedIn can communicate to a student (A) and (B) through the FSNS coordinator. The communication might inform them of notices or feedback on a certain query by the student. The request is directed to the FSNS coordinator that

handles all the orchestration. In the coordinator, the dispatcher in the FSNS interprets the request from M, realises that A is registered on YouTube/Instagram and B is registered on WhatsApp, then asks the BE orchestrator to transparently invoke YouTube/Instagram and WhatsApp and directs all requests to YouTube/Instagram and WhatsApp, thereafter receives feedback from YouTube/Instagram and WhatsApp, and then forward it to SNSs Facebook/LinkedIn—thereby facilitating and controlling communication of client M with A and B using the appropriate protocols. The FE orchestrator is responsible for enrooting the messages/commands/information/data to the destination federated social network application for users M, A and B. Lecturer N creates a class that accommodates all the students in their class: Because the students have various addresses, the dispatcher interprets the command from N and asks the BE orchestrator to invoke the target SNS platform in preparation for the request that would be directed to the students' SNSs for teaching/learning and communication. Students can communicate with each other through the client-to-server or peer-to-peer, whereby in peer-to-peer, each address and platform would have to process the requests by themselves; without the use of the coordinator, each SNSs would be required to have its own coordinator to process its requests and direct the responses to the particular destination. Peer-to-peer communication can be performed by lecturers and administrators as well.

The main modules of the diagram are explained below:

SNS environment

Refers to the social networking application environment provided by specific social networking sites within which users are registered to communicate or connect and share content of special interest.

Address profile

It is the user's identity on the social networking site after being registered to that specific site. Thus it enables a user to enjoy the facilities of a specific SNS, such as content sharing among SNS users. Every registered user has a unique profile.

Peer-to-peer SNS protocol

This is a standard of communication dedicated between two or more social networking sites; it enforces independent communication and procedures without a central controlling/coordinating system. The terms and conditions are independently agreed upon and established between interested social networking sites.

The application layer

The federated social networking layer provides an interface for interaction between the users and the system through features and uses, and characteristics and updates such as video calls, chats, instant messaging, content sharing, knowledge exchange and channels of communication.

Centralised FSNS protocol

A communication standard established among various social networking sites platforms, but through a centralised system which involves an FSNS coordinator and identity provider. Every federated social networking request is made via a central server.

FSNSs coordinator

Responsible for routing messages, commands, data or requests between various federated social network services. It is the core of the centralised FSNS protocol.

Trust relationship

Created through strong business values and ethics that bind FSNS sites in the provision of much-needed services.

8.4.1 Responses to the declared qualitative parameters

The seven (7) quality parameters that guided the experts in reviewing and validating the conceptual framework are presented below according to the order of validation template presentation. The template was designed in such a way that the expert reviewers could provide a brief explanation in commenting on any parameter.

Relevance

The main question that guided the review was: Does the framework address the needs/objectives of the research/study? The constructed conceptual framework should address the problem and fulfil the main objective, as presented in the aim of this study in Chapter 1. The stated aim was also included in the guide to the validation template. Most of the experts agreed on the relevance of the framework without providing a lengthy explanation; some of their comments that included a justification for their agreement are presented below:

"The framework is relevant for the current state of social media and how it [is] used by learners." Expert 4.

"Unfortunately the objectives have not been shared. However, from the information shared, it seems to be relevant basing (sic) *upon the utility value in such a framework."* Expert 7.

Thus, the experts endorsed the relevance of the framework as it seeks to bridge the gap between the negative effects of SNSs, such as students spending more unproductive time on SNSs instead of spending more productive time on SNSs engaging in activities like collaboration, uploading and

downloading learning materials, and even commenting on the various lectures and the material provided.

Logical flow

This parameter tested the practicability of the framework considering the contemporary blended learning era. In addition, the parameter required the experts to comment for or against the stages and constructs and if they were fairly simple for users to follow without difficulty.

"The framework flows logically from the coordination model to the end." Expert 4.

"It's clear how communication will take place across the various social network sites." Experts 5 and 7.

"The framework is logical in its conception." Expert 8.

"The flow is clear for users as it conforms to usual communication flow patterns." Expert 9.

The experts' feedback consistently reiterated that the framework indeed had a logical flow, meaning that the implementers of the framework would have a smooth flow of all the SNS activities.

Completeness

For the framework to function efficiently, it has to embrace the critical components needed in data transmission: security issues and the federation protocols.

"*There is not much detail about how end-to-end transmissions are handled."* Expert 1.

"*The framework is complete and has addressed the key issues."* Expert 2.

"The framework is complete and captures all the necessary areas." Expert 4.

"There may be need to identify criteria for the requests and transmissions that will go through the coordinator and [t]hose which will not pass through the coordinator." Expert 5.

"The framework is complete as it incorporates issues related to trust relationships, architecture, protocols." Expert 8.

"At the technical level details on protocols, media access methods and security maybe needed to validate usability in mobile low data rate environments." Expert 9.

There were mixed reactions regarding the completeness of the framework, with Experts 2, 4 and 8 indicating that the framework was complete, while Experts 1, 5 and 9 added suggestions they thought would make the framework complete if such suggestions were infused into the framework.

Usefulness

The net benefits of the framework for the students, lecturers, administrators and the university community overall.

"The framework is very useful in Zimbabwean universities and beyond." Expert 2.

"The framework creates a very useful set of workflows." Expert 3.

"This framework is very useful and will contribute to the development emerging e-Learning tool." Expert 4.

"Very useful considering the sprouting of blended learning across universities ever since the COVID pandemic began." Expert 5.

"It is a very sound idea which is quite useful in e-Learning." Expert 7.

"The framework lays a clear communication path across all the federated systems." Expert 8.

"Currently these platforms though commonly used and affordable they transfer non-academic content. The framework would validate content and make research easier for the student." Expert 9.

From the experts' feedback, we concluded that the conceptual framework was very useful in the Zimbabwean context and even beyond. Covid-19 and the emergence of blended learning compelled educational systems to consider various eLearning strategies that accommodated learners and students. The issue of validating the students when accessing the SNSs through the federation would make their research easier, and limits would be set for them to remain in the educational environment.

Usability

Such a framework should be designed in a way for users to utilise without problem. The logical flow of processes should be clear for users to understand and follow them without difficulty.

"At high level, it appears usable." Expert 1.

"Its very usable in a university setup." Expert 2

"Its easy to understand." Expert 3

"The framework is well designed and can [be] used without problems." Expert 4

"Framework is usable." Expert 5

"It appears to be easy to adopt." Expert 7.

"The framework articulates[a] path for seamless communication across various SNS[s]." Expert 8

"It is possible to use the framework as a user without any challenges. The flow uses familiar methods." Expert 9.

All the experts noted that the framework could be used in the university without any problems since it is very easy to adopt, per their comments above. They commended the well-designed conceptual framework since the flows were developed using popular networks, which any student, whether or not a computer science or information systems student, should know because of their basic appreciation of the information technology literacy provided to each student as part of their introductory modules. Furthermore, administrators and lecturers all have at least a first degree, which means they also have a basic appreciation of information technology literacy.

Rigour and exactness

The appropriateness of the method to answer the questions and the quality or state of being very exact, careful or with strict precision, i.e., the quality of being thorough and accurate.

"There is rigour and exactness depicted by the model." Expert 1

"The framework addressed all the core tenets." Expert 2

"The framework preparation is very thorough." Expert 3.

"The researcher went through the methodology in designing the framework." Expert 4.

"Few and many are relative terms. There might be [a] need to indicate a threshold for the number [of] users where pee- to-pear communication will be valid." Expert 5.

"Good, but could be improved." Expert 6.

"Try to work on the modelling to make the framework clearer. Use little graphics for some of the components." Expert 7.

"The framework is comprehensive and exact." Expert 8.

"The model can achieve this requirement because of the role of central management through [the] FSN coordinator and also the administrator role." Expert 9.

Comments from most of the experts indicated that the conceptual framework was thoroughly constructed, with all the core tenets addressed; therefore, rigour and exactness had been achieved according to the guide to the explanation of the term given. Expert 5 raised a concern that the conceptual framework did not have a threshold for the number of users that govern peer-to-peer communication. Expert 7 was concerned with the issue of modelling and the use of graphics to make the framework clearer; the expert did not believe rigour and exactness had been realised.

Parsimony

Achieves good levels of predictive and explanatory power concerning its focal phenomena using a small number of constructs, associations and boundary conditions (simplicity) in answer to the question

of whether the framework was practical and the stages involved simple enough to be readily understood by users.

"Parsimony is realised." Expert 1.

"The framework is very practical." Expert 2.

"The framework is (sic) *triggers activities that scale up the project."* Expert 3.

"This is a real-life and practical problem. The framework is therefore practical and the stages involved simple enough to will be readily understood by the users." Expert 4.

"The framework is easy to understand." Expert 5.

"It is somewhat simple." Expert 7.

"The framework is practical and lays [the] ground for a simple, secure and efficient user[s] interaction across various heterogenous systems." Expert 8.

"The framework is very practical and relevant for the Zimbabwean environment or African environment where access to non-predatory sources for research remains a challenge. And also it is the most used platform but for non-academic purposes. Harness its wide user base and easy of use it can improve learning. Peer-Peer links provides good collaboration for student-student and lecturer to student knowledge sharing platform." Expert 9.

According to the experts, the conceptual framework is very practical, simple and easy to understand and use, citing that it is relevant to use in the Zimbabwean context and Africa overall. This would improve eLearning by using the most often used platform, although mostly used for non-academic activities. One purpose of eLearning is to collaborate, and this is said to be realised by the peer-to-peer link provided as a package in the conceptual framework.

Additions that may be fused to the conceptual framework

In a bid to make the conceptual framework applicable, the experts were asked to add anything they felt had been excluded in the development of the conceptual framework, for the comments provided in the sections above to be analysed together with these additions intended for the framework redesign**.**

"It is good. There is, however, not much detail about parsing of data values." Expert 1.

"I think the framework is comprehensive enough and does not need any additions." Expert 4.

"Issues of optimisation might need to be greatly considered considering the amount of traffic that may pass through the coordinator." Expert 5.

"Perhaps you can measure the security aspect of the framework validation." Expert 6.

"The idea of a FSNS is very sound. I understand that each SNS maintains its own integrity. However, my concern is with its security at the instance messages are passed from one SNS to another. Would love to read your problem statement. I would like to understand the advantage of this FSNS over the specific eLearning offerings like Moodlenet. Also consider decentralisation of coordination and if it can yield any advantages over centralisation. Overall, I think this is an awesome framework." Expert 7.

From the comments above, it can be noted that the experts raised critical points like the parsing of data values and the decentralisation of coordination due to the amount of traffic expected to pass through the coordinator.

8.4.2 Critical review of the feedback

This section presents the critical suggestions raised by the experts. The study examines the suggestions to produce constructs that might need to be added to the framework. Such contributions can be classified into two categories:

(i) Constructs that cannot be added to the framework but might be needed as a supporting key to the framework (non-functional requirements).

(ii) Constructs that can be added to the framework immediately after examining the critical relevance of adding them (functional requirements).

We examined the two categories and to determine whether they could be adopted after determining the relevance of the contributions by returning to the literature to gather evidence for the need to adjust. Accordingly, the study discusses the two categories separately:

(i) **Constructs that cannot be added to the framework, although they might be needed as a supporting key to the framework (non-functional requirements).**

The first contribution was the need to identify criteria for the requests and transmissions that would go through the coordinator and those that would not. This contribution was considered valuable but could not be added to the framework design, although these were non-functional needs of the framework and were needed for the smooth flow of the system. The framework is intended to guide and offer ideas or to guide the institutions on how they could make the best of the much maligned SNSs and use them for their benefit by using the SNSs as an eLearning tool.

The second contribution was to work on the modelling to make the framework clearer by using graphics for some of the components. The contribution was considered valuable, which was considered already implemented in Chapter 4 of this study when a model was designed to explain the stages and movement of data in the framework. In addition, use cases were also constructed to support the model with explanations of the actions to be involved in the framework. Lastly, a system flow chart was presented in the same chapter to demonstrate how data would flow from one component to the other.

The third contribution was that there were too few details about parsing data values. The design of the conceptual framework considers that the federation of SNSs will not change the way SNSs operate; thus, the issues of the parsing of data values and their data security will not be examined in detail by the FSNSs. However, the framework would be concerned with the data originating from one SNS and entering another since the model in Chapter 4 presented how data should be handled in the presentation layer.

The fourth contribution was made under the completeness validating parameter, citing that there was not much detail on how end-to-end transmissions are handled; however, this was allowed for when the conceptual framework was developed. The SNSs were considered to have their own end-to-end security features, such as end-to-end encryption. Subsequently, the declared trust relationship will be expected to deal with the security of data entering and exiting their SNSs. In addition, it could be recommended that in transmitting data, these entities consider the use of HTTP requests on their endpoints, implementing various pairs of keys to sign and encode the exchanged data. Standards like *OpenID* or *OAuth* can be implemented (Dodson et al., 2012; Silva et al., 2017).

(ii) **Constructs that can be added to the framework immediately after examining the critical relevance of adding them**

"Issues of optimisation might need to be greatly considered considering the amount of traffic that may pass through the coordinator" and "… Also consider decentralisation of coordination and if it can yield any advantages over centralisation …" Expert 5 and Expert 7, respectively.

This study regards this contribution as one factor since all the contributions were pointing towards the decentralisation of the coordinator to ease the traffic passing through it, considering how large the data that would be handled by the eLearning tool is expected to be. This was considered a valuable contribution due to the amount of data a university deals with. For example, at a university like Midlands State University with around 20 000 students and 1 000 lecturers, large amounts of data are expected to pass through one coordinator, which might delay the transmission of data, and because the coordinator could become a central point of attack to violate security properties affecting the whole network (Bahri, Carminati & Ferrari, 2018; Eskandarian et al., 2017; Hojati et al., 2021).

8.5 Redesign of the framework

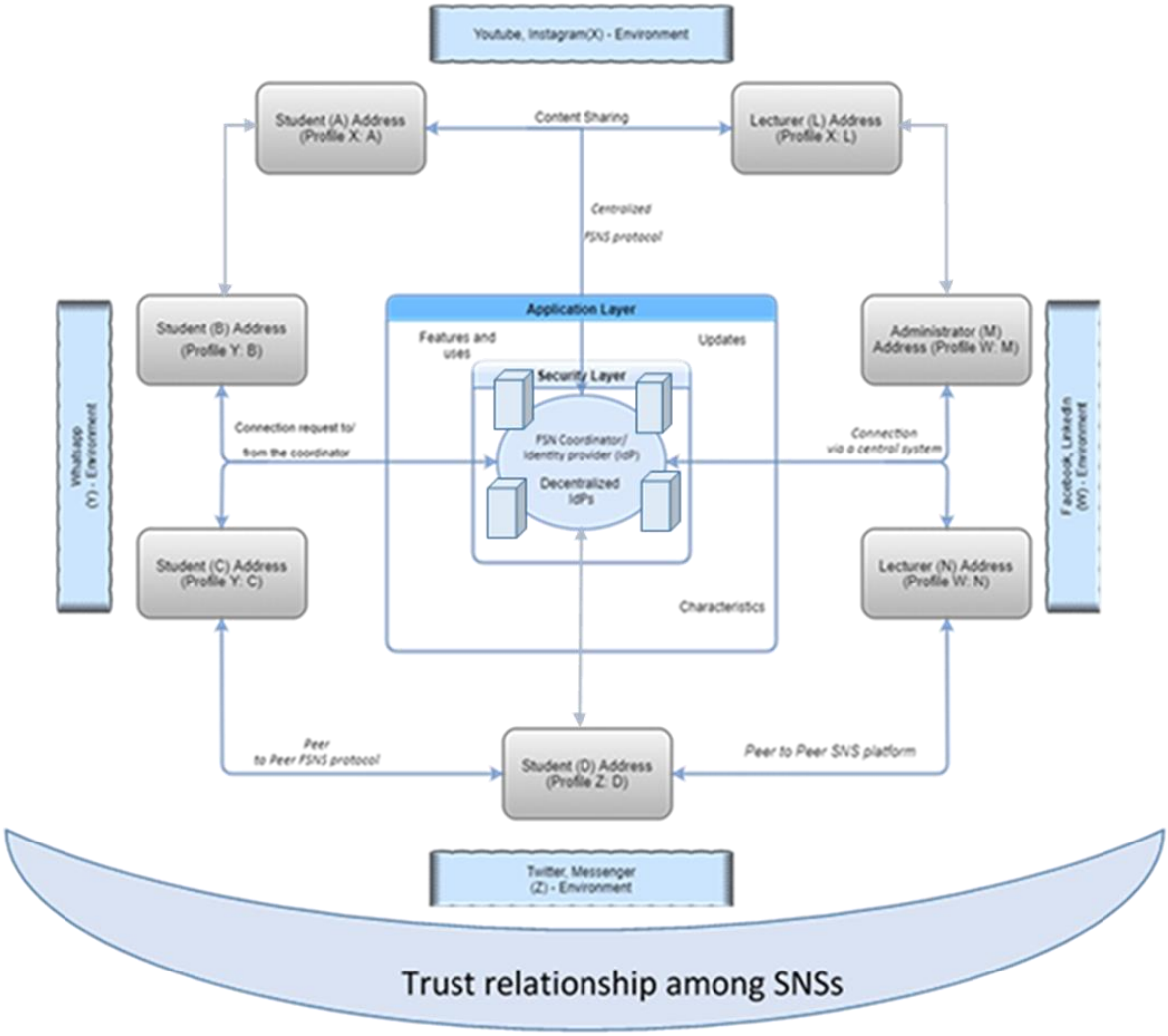


Figure 8.3: Improved framework

8.6: Comparison of the initial framework and the improved framework

By accepting the experts' contributions, the framework was redesigned to incorporate additional input. The FSNS coordinators were increased to four to share the load, in conjunction with the architectures of the SNSs studied in Chapter 3, whereby their servers are in more than one tier to share the load, thereby reducing the response time as well as improving performance, scalability and availability (Rohani and Hock, 2010). In addition, the study added a security layer between the application layer and the coordinators; this can include firewalls and employing GPG encryption on messages (Cabello et al., 2013). Peer-to-peer and client-to-server communication were enabled on all roleplayers in the network, which means the communication would either go through the peer-to-peer or client-to-server networks, depending on which way was free to accept the request. Other factors considered when transmitting data were the sensitivity of data concerning security data that require high security might need to be directly transmitted to the final destination without passing through the central coordination. Due to its scalability features, the client-server route would be used when broadcasting messages to many students.

8.7 Discussions and Findings

The literature review in Chapter 2 explored the categories of social networking sites (SNSs), their architecture and the common trends that relate to the entirety of SNSs. Thus, it provided a study base which ushered in the concept of federated social networking sites (FSNSs). The literature reviews also highlighted that no studies had explicitly considered the imperative function of FSNSs in the higher education sector. Currently, no existing literature has shown interest in the study of federated SNS for eLearning purposes in developing countries. Hence, the study identified a deficiency in research on the creation of an FSNS framework in the context of Zimbabwe's higher education environment. The succeeding Chapter 3 further provided the typology of SNSs by generating the basis for FSNSs. Chapter 4 of the study investigated various conceptual frameworks for federated social networking sites, including the study's adopted conceptual model. In Chapter 5, the study provided the research methods and philosophy that had been pursued to collect data from the respondents.

Chapter 6 provided the qualitative and quantitative results attained from the study, while Chapter 7 presented the FSNS framework validation and redesign to reflect the needs for an FSNS in the Zimbabwean environment. Therefore, this juncture discusses findings from the study in line with the research objectives supported by existing literature.

8.7.1 SNSs most often used by students at higher education institutions.

Findings from the study observed that WhatsApp was the most often used SNS site, with a total of 215 respondents in favour of this social media application. The second most popular SNS was Facebook, with 205 respondents, followed by YouTube (166), Instagram (143) and Twitter (122), constituting the top five most often used SNSs in higher education. Dixon (2022) seconds the view that WhatsApp, YouTube, Instagram and Facebook are among the top SNSs most often used, while Id et al. (2020) and Tarisayi (2021) identify WhatsApp as the most visited site by June 2022. While academic sites such as *Academia*, *Mendeley* and *ResearchGate* are very useful (Thelwall and Kousha, 2014, p. 721) this study observed that they are considerably complemented by the above-mentioned top five SNSs most often used in higher education.

8.7.2 Uses of SNSs by universities

The study identified that social networks are currently used for sending and receiving learning material, usually among students, lecturers and administrators, which is also supported by Ahn (2011). More so, social networks are currently being pursued for collaborative learning through group discussions (Toetenel, 2014). They are also used for general announcements between students and lecturers or special announcements by the university administration. Currently, students forward their assignments using social networking platforms, as noted by Lee et al. (2016). In turn, lecturers provide feedback to students by using the same social networking platforms.

8.7.3 Benefits of using SNSs as an eLearning tool.

Social networking sites are rich in all types of information, be it social, academic or business; accordingly, every social network user benefits in some way. The developers of such sites are constantly pursuing research that ensures these SNSs would fulfil their purpose in all communication spheres, such as business, academic and social. Bucher (2015) expresses that presently, content does not only come from the service provider but rather that users have become major contributors of content by uploading and sharing data and links.

8.7.3.1 Easy conveyance of messages

Today, social networks have become indispensable since they have become communication tools for sending and receiving information; hence, the unavailability of social networks would mean missing critical information (Alhabash & Ma, 2017). At present, it has become difficult for the digital generation to 'barely survive' without social media network communication. Nonetheless, not only learning institutions but also the business community have adopted social networking to convey important information formally. The reason for the moniker 'social network' is in reference to developing academic friendships, building relationships and connecting with others, all of which are essential to discovering opportunities while studying towards future benefit.

Ease of conveyance is one of the factors imperative to making administrative work easier at learning institutions. The study notes that administrators (13.9%) and lecturers (26.3%) cite ease of conveyance as an advantage of using social networks. In addition, lecturers and administrators find them indispensable tools for achieving academic communication. During the Covid-19 pandemic, social networks served best for communication purposes, promoting less physical contact and social distancing.

One of the important benefits of social networks is the facility of instant delivery (Alhabash & Ma, 2017; Buhari & Ahmad, 2014). Due to the various social networks in existence, SNs make it easy to forward the same copied message targeting different users and have become the fastest way of communication. Social networks guarantee that information will be received by every communication party while connected; for example, WhatsApp, Facebook Live and Instagram Live allow real-time discussions and content sharing. Lecturers (24.4%) and administrators (22.2%) point out that everyone is a subscriber to at least one social networking platform; consequently, messages are guaranteed to reach the intended recipients. Thus, two-way communication between lecturers and students becomes easy, which was supported by 23.6% of university administrators.

8.7.4 Cost-effectiveness

Administrators (40.3%) and lecturers (24%) confirm that social networking sites are a cost-effective way for academic delivery. More so, social networking sites have made communication much cheaper than traditional ways, like using a physical post office (Bocar & Jocson, 2022; (Ezumah and Hall, 2013)). This point is also raised by Pilli (2014, p. 90), who expresses that social media is a way to

provide ways of communication cheaper than traditional promotion and advertising activities; hence, the cost of maintaining communication on social media remains minimal.

8.7.5 Free learning environment

Social media platforms allow a flexible academic environment between lecturers and students as they allow them to connect outside the classroom environment to share ideas and resources and create discussion groups, as stated by Ahn (2011) and Boyd (2007). Principally, SNSs in eLearning environments provide students with a sense of community and belonging. Students and lecturers create groups, thereby generating a sense of unity by providing psychological support and motivation. Students (40%) confirmed that those who lack the confidence to ask questions in class and share their ideas can do so freely through SNSs which, at the same time, are more fun than formal classroom learning.

8.7.6 Friendly learning features

Lectures and students can take advantage of the friendly features provided by social network platforms which can be used for learning purposes, for instance, document, audio and video attachments that can be shared among users of SNSs, hence interaction on SNSs is flexible. Eke, Omekwu and Odoh (2014, p. 6) argue that having interactions in SNSs groups is becoming more academically enhanced than having a physically present instructor. In this way, students not only gain knowledge but also engage in learning from anywhere and whenever they need to. Students (24.4%) noted that features like video clip replay, redownload and fast-forward help them re-access the requisite learning content, as well as better understand concepts in harmony with individual comprehension rates.

The use of social media platforms such as blogging or group features allows students and lecturers the opportunity to pursue discussions, thereby fostering a much-needed participatory culture in the academic environment (Gupta, 2014). The nature of any academic environment should be concretised in discussions on diverging and converging ideas. Thus, social media provides such features as a benefit of eLearning. Munene and Nyaribo (2013) support the assertion that social media networks provide a platform for content sharing, collaborative learning and enhancing professional relationships.

8.8 Centralised Social Networks Architecture

The most popular social networking sites of the modern day, such as Facebook, Twitter, LinkedIn and WhatsApp, are based on centralised server architecture (Jiang & Hu, 2020; (Raman *et al.*, 2019)). In such a setup, the central servers for these SNSs are responsible for handling queries and storing information for their users. Users of these centralised SNSs have no control over their information. Therefore, it is important to note that the most popular current social network sites have challenges in the academic environment, as discussed below.

8.8.1 Lack of interoperability

A successful learning environment is achieved by sharing content between social networking sites. Unlike the email world, where there is SMPT collaboration within service providers or the HTTP, which is the interoperability of the web, bigger social networking sites, such as Facebook, Instagram and LinkedIn, do not have options for users to share data across platforms (Raman et al., 2019b; Wang, 2022). To wit, the relationship among current social networking sites can best be described as fragmented. This means students need to register with a specific SNS to communicate with a colleague on the same platform, popularly known as the lock-in effect, becoming a challenge to share education content using SNSs, especially when not registered to a particular SNS being used by other students.

8.8.2 Privacy issues

Because most SNSs are centralised, social media users' concerns have increased, especially about the security of what they post (Hutton & Henderson, 2013). SNSs have the license to do with users' data and content whatever they deem necessary, rather than service providers owning all users' data. Consequently, users' personal data are exposed to data breaches, especially where third parties are involved.

8.8.3 Scalability challenges

As social media popularity is increasing tremendously, SNS users can not only access content but also generate it in many forms. Thus, there is an overwhelming scalability challenge emanating from the huge amounts of data currently being generated, increased data traffic as well as huge storage requirements (Bielenberg *et al.*, 2012).

8.8.4 Platform dependency

The lack of interoperability by centralised SNSs poses a challenge to students who depend heavily on a specific SNS for communication or content sharing (Dadkhahan, 2012; Jiang & Hu, 2020). This has created an oligopoly within social networking site environments, which is not conducive to learning environments as it stifles initiative, creativity and ease of accessing information.

8.8.5 Lack of freedom

Contemporary students should exercise freedom of expression and association. However, social network platforms having control over users' data and created content has stifled the freedom of speech and creativity of users. Segado-Boj and Díaz-Campo (2020) identify arbitrary censorship, boundaries of speech and data profiling as factors that might hinder a free learning environment for students.

8.9 Sites that should be incorporated into the FSNS

Findings from the study identified the following as the most popular social networking sites that should be part of the HFSNS: Facebook (76.5%), WhatsApp (72.5%), Twitter (47.1%), YouTube (23.5%), Instagram (9.8%), MySpace (3.9%), Sasai (3.9%) and LinkedIn (3.9%). These are the modern-day

leaders in the provision of social networking in business, academia or general social environments (Abdulwahab, 2015).

8.10 A Hybrid Federated Social Networking Site (HFSNS) as a Learning Tool

This study proposes a hybrid FSNS in an attempt to enable social media applications to counteract the above-mentioned centralised SNS platform challenges, such as the lack of interoperability, scalability, privacy, security and freedom and platform dependency (Tarameshloo, Fong and Mohassel, 2014a; Silva et al., 2017). It is an integration of peer-to-peer and decentralised SNSs architectures. The proposed HFSNS networking framework allows cross-platform communication using the uniform resource locator (URL) of the profile page of that external user. Jiang and Hu (2020) explain that distributed social networking sites such as FSNS are not only convenient for social network users but can also achieve academic objectives and drastically lower costs for academic institutions in terms of operational costs. Similarly, there are lowered costs on central data collection and management, hence quite a substantial release of the central storage burden. In addition, HFSNS sites aim to provide an unbound platform where users own their online profiles and can dictate the terms of their social network connections. However, FSNS service providers impose a set of reasonable user terms so that users do not abuse the facility. Examples of such protocols are *Diaspora, OStatus Suite, Status Net* and *GNU Social* (Bielenberg et al., 2012; Gehl, 2015).

8.10.1 Quality parameters guiding the proposed FSNS framework

The proposed framework design was guided by seven (7) quality parameters used in reviewing and validating the FSNS framework. Using these parameters, nine expert reviewers contributed through analyses and recommendations.

8.10.1.1 Relevance

A conceptual framework is meant to argue a case on why a study is relevant and how the study design rigorously answers the research questions Ravitch and Carl (2020). In that regard, expert reviewers concurred the proposed FSNS framework was relevant, especially in current academic spheres of higher education, where social networking contributes immensely to the eLearning processes. In line with that, Al-Mukhaini (2014) opines on the need for social network s frameworks in higher education to enhance contemporary learning. The framework also plays a critical part in negating the negative effects of social networks, such as spending more time on the platform unproductively and instead taking advantage of such time for productive academic work, such as downloading or uploading educational content and indulging in collaborative work.

8.10.1.2 Logical flow

The conceptual framework attempted to offer a logical structure of connected eLearning concepts found within social media network facilities. It provided a visual representation of how the concepts being investigated by the study closely relate to each other, in line with (Grant and Osanloo, 2014). The

reviewers pointed out that the study's ideas on the application of social networking sites in eLearning are broadly related to one another within the FSNS framework. For instance, the reviewers described how communication takes place between different SNSs, which critically identifies the authors' epistemological and ontological worldviews.

8.10.1.3 Completeness

The expert reviewers affirmed that the framework provided comprehensive information on how the hybrid FSNS framework was supposed to work since completeness is a key quality feature of any sound framework as it makes it useable or applicable (Nilsen, 2015) Protocols, architecture, entities and trust relationships were established, as noted by the expert reviewers. Nonetheless, one reviewer provided the valuable recommendation that there should be a criterion for the request and transmission going through the coordinator. However, that could not be added to the framework due to parsimony, as covered in Subsection 8.5.1.7.

8.10.1.4 Usefulness

As relates Zimbabwean higher education environment, the expert reviewers agreed that the hybrid FSNS framework was very useful and could negate the matter of insufficient resources in the academic environment. The peak of the Covid-19 pandemic required strict online interfacing between students and lecturers, and consequently, eLearning platforms like social networks emerged as the panacea for successful academic delivery (Roman & Plopeanu, 2021). Students, lecturers, administration and the university as a community are the stakeholders mostly expected to benefit.

8.10.1.5 Rigour and exactness

The attributes of rigour and exactness are considered best practices for qualitative research design as they relate to the steps of designing a framework (Nilsen, 2015; Ravitch and Carl, 2020) Rigour is supported by appropriate research questions and methods (Maxwell, 2011; Peersman & Rugg, 2010). The expert reviewers affirmed that the hybrid framework was supported by appropriate objectives and the study's research methods. In addition, the expert reviewers noted that the framework addressed all the key tenets of the social networking environment in higher education—hence it is comprehensive.

8.10.1.6 Parsimony

Parsimonious frameworks are simple frameworks characterised by great explanatory predictive power (Peersman and Rugg, 2010; Conole, Galley and Culver, 2011; Maxwell, 2011). High parsimony means a minimum number or just the right number of predictors, parameters or variables needed to explain the framework well. In contrast, low parsimony has many parameters that tend to be complex in explaining a conceptual model (Foroughi, 2011; Maxwell, 2012; Venable, Pries-Heje and Baskerville, 2016) In scrutinising the higher education environment, the experts agreed that the number of constructs present in the FSNS framework provided simplified boundary conditions and activities, for instance, how SNSs are either P2P connected, through the central server, or both. Therefore, the

framework lays the ground for simple, secure and efficient user interaction across various heterogeneous systems. By so doing, it could improve the nature of social network-based eLearning platforms through collaboration or peer-to-peer interfacing.

8.11 Reliability of the research instruments

The study employed reliability tests to ensure consistency was maintained in measuring data. When done repeatedly using the same methods, it should produce the same results given the same circumstances (Livingston et al., 2018). A reliability test was conducted to determine whether the questionnaire survey tool consistently achieved the same results using this same method, given the same higher education environment (Bonett & Wright, 2017). In that regard, Cronbach's alpha (α) test was employed to measure the internal consistency of how closely related the responses within each group of administrators, lecturers and students were. The following table presents the measure of internal consistency and its interpretation.

Table 8. 1 Internal Consistency Interpretation

Cronbach's Alpha	**Internal Consistency (Interpretation)**
$\alpha > 0.9$	Excellent
$0.8 <= \alpha < 0.9$	Good
$0.7 <= \alpha < 0.8$	Acceptable
$0.6 <= \alpha < 0.7$	Questionable
$0.5 < \alpha <= 0.6$	Poor
$\alpha <= 0.5$	Unacceptable

Source: Livingston et al. (2018)

Using 484 items for Cronbach's alpha for the students' questionnaire, the α obtained was 0.936, and the lecturers' questionnaire from the study attained an α value of 0.941. Therefore, Table 8.1 displays that the internal consistency of the questionnaire survey tool was excellent for both students and lecturers. The administrators' questionnaire attained an α value of 0.856, which is deemed good for the research method, and furthermore, the research tool was highly consistent, hence contributing to the trustworthiness of the research.

8.11.1 Missing values and normality testing

In statistics, missing values, also known as missing data, occur when no data are captured for a variable in an observation, in this case, a question on a questionnaire (Ghasemi and Zahediasl, 2012). Missing values were dealt with in the questionnaires, in which every question was marked compulsory, and a respondent could not proceed to the next question before providing an answer. A normality test was pursued to determine whether the sample data drawn from the study represented a normally distributed

population. Unlike a parametric test that assumes population parameters such as mean and standard deviation, the study chose a non-parametric or a free distribution test that did not assume anything about the underlying normal distribution (Arkkelin, 2014). Thus, the study adopted the Kolmogorov–Smirnov (KS) and Shapiro–Wilk tests to determine whether datasets differed significantly while, at the same time, making no assumptions about data distribution. These tests represent some general normality tests designed to detect all departures from data normality. After data normality testing had been conducted, all the items' sign values fell below 0.05 in both the Kolmogorov-Smirnov and Shapiro-Wilk tests. Therefore, the study interprets that the data from the study were not normally distributed because general data were used to group data such as age data since the study observed that students who participated in the study were approximately the same age. In addition, lecturers and administrators who participated in the study generally had the same levels of qualification and were somewhat bound to respond in the same manner.

8.11.2 Determining the correlation of variables

The study identified the three critical players in the adoption and implementation of FSNS in higher education: students, lecturers and administrators. Students are involved in downloading, uploading and creating academic group platforms, while lecturers instruct, upload and download students' content using the same platforms. Administrators are responsible for conveying certain important information or notices to both students and lecturers (Abed, 2019; Dhawan, 2020; Kuimova et al., 2016).

For the students, Spearman's Correlation Coefficient for the bivariate analysis was employed to find the relationships in age, gender and area of specialisation and, whether within these, they were directly, inversely or not related to SNSs membership. The Kruskal–Wallis test was done to verify whether or not specialisation or area of study affected SNSs subscription (Akoglu, 2018). The three variables provided the following outcomes: (i) age (0.090), (ii) gender 0.017), and (iii) specialisation (-0.056). The Kruskal–Wallis test was conducted to verify whether or not specialisation or the areas of study of lecturers and administrators affected the usage of SNSs (Almalki et al., 2016). Three demographic variables, namely age (0.092), gender (-0.031) and area of specialisation (0.060), were guided by Section 6.2.5 of this study. The Kruskal–Wallis test showed that the usage of SNSs was in no way related to the area of study, and the different specialisation area groups had no significant impact, as shown in the lecturers' outcome of 0.422, which is > 0.05, and administration showed 0.159, which is also > 0.05.

Three demographic variables, that is, age, gender and area of specialisation were chosen to ascertain the effects of age on the usage of social networking sites by students, lecturers and administrators. From the Kruskal–Wallis test with students, the asymptotic significance of age was 0.293, gender was 0.910, and the area of specialisation was 0.148, which is greater than 0.05. The lecturers' Kruskal–Wallis test on the asymptotic significance of age was 0.096, gender was 0.216, and area of specialisation was 0.422, which is greater than 0.05. The administrators' Kruskal–Wallis test on the asymptotic

significance of age was 0.226, and the area of specialisation was 0.159, which is greater than 0.05. Further, the asymptotic significance of gender was 0.026, which is also less than 0.05.

Using 95% confidence in all cases of age, gender and area of specialisation on students, lecturers and administrators, the study accepts the null hypothesis, whereby age, gender and area of specialisation have no effect on SNSs subscription in university institutions. The gender case on administrators showed otherwise, hence the rejection of the null hypothesis that gender is independent of SNS usage in the university environment.

Factor Analysis

The study pursued factor analysis as a technique used to reduce a large number of variables to fewer numbers of factors. The technique intended to extract the maximum common variance from all variables from lecturers and students and put them into a common score (Watkins, 2018). As such, factor analysis was conducted on the characteristics, features and uses of SNSs to classify the 23 items into a manageable number of components. The KMO and Bartlett's tests were utilised to test if the data were fit to be considered for factor analysis; the students' and lecturers' data proved fit, factored with a p=0.000 and Chi-square value of 5233.951 on Bartlett's test and a KMO of 0.951, which is acceptable as it is greater than the minimum value of 0.50 (Faller et al., 2006).

Regarding the administrators, factor analysis could not be conducted with 52 of the participants on characteristics, features and uses as they were not fit to be factored. From the 23 components observed from both the students' and lecturers' data, three components from each of the two datasets scored Eigenvalues of above one (1), which means that characteristics, features and uses could be grouped into three categories. With students, the first component achieved a very high Eigenvalue of 12.119, the second reached 1.609, and the third component had 1.002, while the first component of the lecturers' data achieved 12.5118, the second reached 1.833 and the third had 1.018, which also implies that characteristics, features and uses could be classified into three categories.

Mean determination

The study calculated the means of the SNSs to be used and the services to be included; the criteria were used to find the number common to all the clusters (students, lecturers and administrators). This was a decision-making tool employed after obtaining different figures from each cluster. From the student cluster, the mean number of SNSs to be included was 4.6614, lecturers had 5.2569 and administrators 9.4423; the mean of the three clusters was 6.45, whereby the services to be included were students (10.7310), lecturers (9.8211) and administrators (13.7308). Therefore, the mean of the three clusters became 11. 427, leading to the decision to include seven SNSs in the federation of SNSs and 12 services to be offered by the HFSNS tool.

8.12 Summary

Chapter 8 presented the expert review of the conceptual framework presented in Chapter 5 and redesigned in Section 8.2 after filtering in the feedback from the quantitative data analysis. The expert review was based on the seven qualitative parameters stated and defined in the validation guide to enable uniform interpretation of the parameters and, therefore, consistency in the feedback sought by the study. In addition, the experts were provided with two additional options to state whether there was a need for any additions to the framework, and there was both or a need to remove anything from the conceptual framework. These actions needed justification and clarification.

The experts' comments were critically examined, and the study produced two categories of the responses regarded as the non-functional and functional requirements. The functional requirements are the constructs that can be added to the conceptual framework directly and determine what the framework will do, and the non-functional requirements are the constructs that can be added to the background operations / backend development, and the non-functional requirements determine how the framework will fulfil its objectives.

The functional requirements suggested were taken into consideration, i.e., the issue of decentralisation of the coordination, to ease the workload of the central coordinator. Consequently, the framework was redesigned to accommodate the changes, although the conceptual framework retained all the constructs originally developed. The last and main objective of this study has been met through the improved framework presented in this chapter. The improved framework underwent two stages of improvement, and the resultant framework is expected to work well in the environment it was designed for, considering that the key participants would be using it and their current environment is where it would operate. This chapter also fulfils the objectives of the second principle of the DSM framework development process, namely, to evaluate, and Dubin's last four stages of the theory development process that focuses on the verification of the developed framework. Thus, this chapter successfully answered Sub-Research Question 4: *How can federated SNSs be validated and improved to obtain an improved version that can be used as an eLearning tool in universities?*

This chapter also reflected and discussed findings from Chapter 7 and the first section of this chapter representing quantitative and qualitative data analysis, respectively. This was concretised in the research questions and scope, as set in Chapter 1, as well as the literature review in Chapter 2. To wit, this chapter provided a coherent relationship with existing research or theory and empirical data findings. The next stage of the study is reflected in Chapter 9 by presenting a summary and conclusion, the contribution of this research, and recommendations for future research.

Chapter 9 : Summary, Conclusions and Future Work

9.1 Introduction

This chapter seeks to present a summary of the chapters in the thesis, demonstrating that all the research objectives (main RO and sub-ROs) were met and consequently, the research questions have been answered. The main objective of this study was to develop an FSNS framework to be used as a tool for eLearning at universities. The first part (build) of the development process started in Chapter 2, with the literature, eLearning frameworks, theories and tools forming a basis and foundation of a robust framework and was completed in Chapter 5. The second part (evaluate) of the development process continued in Chapter 6, where data collection was declared, undertaken and analysed to produce the desired FSNS4eL framework in Chapter 8, ending the framework development process.

The previous two chapters comprehensively discussed the data findings, i.e., Chapter 7 (quantitative) and in Chapter 8 (qualitative). The discussion of results in Chapter 8 defined the connection between the findings from primary data and the extant literature to pave the way for the final chapter, with the task of providing conclusions based on the discussion of the findings.

The chapter also presents the contributions of this study to eLearning in Zimbabwean university systems and university systems worldwide. This study has some limitations discussed in this chapter to provide suggestions for future research studies on how to overcome or avoid such limitations. Lastly, a summary of the current chapter is provided.

9.2 Summary

In this section, all chapters are summarised to briefly demonstrate the coherence between the research objectives and the chapters of this study. Table 9.1 demonstrates the objective that was achieved, in the chapter it was achieved and the research contribution that was realised.

Table 9. 1: Matching objectives with chapters and research contributions

Objective	Chapter(s)	Research contributions
	Chapter 1	One
To study the overview of SNSs and determine SNSs used by university students.	Chapter 2, Chapter 3	Two
To explore existing eLearning frameworks to build a strong foundation for the proposed eLearning framework.	Chapter 4	Three, four
To evaluate and validate the proposed conceptual FSNS4eL and then deliver an improved version for further adoption.	Chapter 5, Chapter 7, Chapter 8 and Chapter 9	Three, four, five, Six

The first chapter introduced the study and stated the motivation for the study. The chapter discussed the background to the study, the problem statement, the aims of the study, the objectives of the study and the questions to be answered to fulfil the objectives of the research. The main research objective of this study was to develop an SNS federated framework to be used as an eLearning tool by universities; all other objectives and the research methodology were presented and introduced in Chapter 1 for the study to achieve its main objective. The chapter presented some theoretical statements underpinning the study and indicated the proposed contributions of the study, discussed ethical considerations and presented the thesis structure.

Chapter 2 investigated the characteristics of SNSs by defining the social networks and explaining their characteristics to equip the reader with an appreciation of the main terms used in the rest of the thesis. The chapter discussed the functions of SNSs, specifically those benefiting students in eLearning-related or academic activities, at length, namely identity management, expert search, context awareness,

contact management, network awareness and exchange. Further, the chapter deliberated on the positive characteristics of SNSs in education as well as the limitations and security issues around SNSs. Chapter 2 provided a general description of SNSs, which detailed the characteristics, benefits and limitations of SNSs.

In addition, an introduction to the types of social networking sites was provided, as well as an indication of the most visited sites within an academic context as a method of communication in higher education institutions. This was done by indicating groups of SNSs presented by the literature reviewed; these groups are business-oriented, nonbusiness-oriented and academically oriented SNSs. The chapter introduced SNSs as an eLearning tool and supplied the reasons why SNSs are increasingly becoming relevant as eLearning tools.

The last item discussed in Chapter 2 was the general architecture of SNSs, to gain an understanding of how SNSs operate and what is involved in the development of SNSs to ensure that when the proposed Framework is developed, its architecture would not diverge from the architectures of the SNSs to be federated. The discussion provided a basic prototype of the general architecture that could represent a huge networking site like Facebook or YouTube. Such architecture includes the application servers that manage service availability and the access protocols of users, memory caches 'listening' to the TCP socket for requests, maintaining hash tables to rapidly respond to metadata keyword searches and, lastly, the database servers and databases where major sites pair each server with a backup server for its backup to take over the processing load when a server crashes—to maintain the efficiency and effectiveness of service delivery.

Chapter 3 undertook an overview of existing SNSs and, in particular, discussed four SNSs regarded as the main SNSs, in detail and scrutinised the backgrounds, features and architectures of those SNSs. This was undertaken to shape a background theory on their features and concepts to either or both adopt and adapt in the development of the FSN framework.

The chapter discussed the background and history of Facebook, which was first developed in 2004 by Mark Zuckerberg with his friends at college, and in its extension, companies like Accel Partners, Greylock Partners, Meritech Capital Partners, Microsoft and entrepreneur Peter Thiel invested in Facebook by buying shares. Furthermore, Facebook acquired Instagram, WhatsApp and Oculus as a way to diversify. The Facebook features discussed in the chapter were (i) a search engine for classmates, friends and co-workers providing suggestions to befriend people who had attended the same school, worked at the same company and even lived in the same neighbourhood; (ii) a newsfeed, which is an update of what had transpired when the user was offline; (iii) applications such as *EdgeRank* that ensure that relevant content appears in the appropriate user's newsfeed, and messenger, which is a convenient way to send messages to without having to navigate to the website, (iv) fan pages where users can interact in accordance with similar areas of interest; (v) a wall on which friends can write and view public comments written by other users; (vi) photo album management, whereby Facebook provides a

platform for uploading photos into online albums and on user profiles as profile pictures; (vii) groups users can join based on common interests, courses or even inside jokes; (viii) a timeline facilitating user access to a list of every action they have ever taken on Facebook; and (ix) Facebook connect, which allows users to log in to other websites using their Facebook information. Table 3.1 in Chapter 3 summarises the uses of Facebook.

The last aspect of Facebook is its architecture, where the chapter revealed that the application uses a three-tier client-to-server network because of its large number of subscribers. For development, it uses software like *Linux*, *Apache Server*, *MySQL*, *PHP*, *C++* and *Java*; in addition, the company developed a framework called *Thrift*, which supports over 15 languages, including *C++*, *C##*, *Java*, *Python*, *Ruby*, *Erlang*, *Perl* and *Hack*, among others.

The history of LinkedIn dates back to 2002, when, in the living room of co-founder Reid Hoffman, it was officially launched on 5 May, 2003, as a networking site for professionals to connect virtually without having to meet in person; by 2016, LinkedIn was available in 24 languages. The founders of LinkedIn were Reid Hoffman and executives from PayPal and SocialNet.com. LinkedIn had many leaders after Reid stepped down, bringing in Dan Nye as CEO, then Jeff Weiner as president and Deep Nishar as VP; eventually, Jeff Weiner became CEO, and Reid Hoffman remained as chairman. Most of LinkedIn's income is from *Talent Solutions*, which includes recruiting tools and online education courses; *Marketing Solutions*, which allows individuals and enterprises to advertise to LinkedIn's PSN members; and the Premium Subscriptions feature for both consumers and businesses. In a bid to expand, the company acquired many companies and service providers like ChoiceVendor, mSpoke, CardMunch Inc., Rapportive, SlideShare, Esaya, Mumbo, Pulse, Bright, Bizo, Newsle and lynda.com. On 11 June 2016, Microsoft and LinkedIn signed an agreement plan of merger, by which Microsoft acquired all LinkedIn shares. Chapter 3 also discussed the following LinkedIn features: Groups, SlideShare, Pulse, Native Video, Advanced Search, Messaging, Recommendations, Customised Notifications, InMail, Lynda, Analytics and University Pages. The chapter further detail the uses and architecture of LinkedIn, namely that it is also serviced by a three-tier client server architecture with two main technical aspects: (i) LinkedIn Communication Systems responsible for functionalities like email and profile and (ii) LinkedIn Network Updates system, which is more like an RSS newsfeed. Unlike Facebook, LinkedIn is coded in *Java*, except for a few services.

YouTube was founded by former PayPal employees Chad Hurley, Steve Chen and Jawed Karim at a dinner party in San Francisco and registered by Chad Hurley on Valentine's Day, 2005. The application was founded as a platform for amateurs to upload and send videos online. In October 2006, the company was purchased by Google and progressed from a site for amateurs to an online platform populated by commercial and professional videos. Its income is generated by advertising and banner ads in videos by playing commercials during the streaming of videos.

YouTube features are: comments, subscriber notifications, new types of cards, easier access to the subscription feed, faster and more useful creator studio applications, video management on the go, 360-degree videos, better live streams, a new creator community, updated creator academy, and flagging features. The chapter further discussed the uses of YouTube under two groups, namely education and entertainment. The last discussion on YouTube was its architecture, which revealed that, as with Facebook and LinkedIn, YouTube had a three-tier physical server cache hierarchy, albeit with at least 38 primary locations, eight secondary locations and five tertiary locations as part of its video delivery system. The video delivery system has four main components, namely YouTube video ID space, three-tier (physical) server cache hierarchy and their locations, multi-layered anycast DNS namespaces and unicast namespace.

Twitter is a real-time communication platform founded in 2006, which supports 140-character tweets. Its revenue model uses promoted tweets, promoted trends and promoted accounts for advertising. Messages posted on Twitter can be seen and responded to instantly, and the flow of messages is constantly refreshed to elicit new updates. This platform is convenient for communicating shared events like earthquakes, sports updates, festivals or the Covid-19 pandemic, with tweets sent as real-time updates.

Twitter features include users changing their profile layout, the @feedback option where all feedback is posted, viewing all people who are following a user through a follow request, viewing recently accessed profiles and some privacy options such as tweet privacy and tweet location.

In sum, the uses of Twitter in eLearning are: to post advertisements, as a tool for review and homework, as a tool to break down barriers, for better communication, to create a questionnaire or for voting, as a digital lounge, as a brainstorming tool; as a calendar tool, and as a tool for collecting and sharing resources.

The Twitter architecture consists of a back-end service layer used for inserting and retrieving tweets using MemCaches. The second component is the search engine layer implemented using *Apache Lucene,* a high-performance and full-featured text search engine library programmed in *Java* using inverted indexing of warehoused tweets, making word search responses very fast. The middle layer is used as a queueing system to avoid overloading the back-end service layer. The front-end service uses the *Ruby on Rails* framework written in *Java,* which handles all requests to the Twitter system by pre-calculating and delegating the requests for proper handling through the whole system. The last component is the online GUIs with all the Twitter features used in the system.

Chapter 3 also explained the three principles guiding the development of a framework for the federation of SNSs as an eLearning tool, summarised thus: linked data involving the creation of identifiers for things or resources on the web and then linking these resources, using statements in a standard format called RDF (resource description framework); service decoupling making the prospective services

small and separate yet as integrated as possible to simplify choosing between services and applications; and lastly, protocol and architectural minimalism assisting with the definition of the boundaries of the framework to prevent unnecessary data being kept.

Chapter 4 discussed eLearning frameworks by defining eLearning and explaining the basic concepts associated with eLearning, as investigated by this study, including eLearning tools such as the internet, CD-ROM, the internal network (intranet), video conferencing (video conferences), audio conferences, interactive videos, satellite programmes and virtual classrooms. The discussion led to explaining the types of eLearning, namely online learning, distance learning, blended learning and M-learning, and the unique characteristics of each. The benefits and limitations of these eLearning modes and processes were articulated, such as limited technology to fully embrace the eLearning process, poor network connectivity, insufficient electricity connections, a lack of electronic devices, poor infrastructure, constant power outages, inadequate computer laboratories, inadequate IT support and an eLearning policy, unsuitable home environments and an absence of support from university management. The chapter reviewed the different types of eLearning frameworks, including (i) Khan's eLearning framework, designed to create an effective environment for learners and instructors to abandon a closed system learning design mentality; (ii) the blended multimedia-based eLearning applications framework, combining face-to-face and eLearning systems that employ synchronous and asynchronous media to gain maximum benefit of the system; (iii) the eLearning systems theoretical framework encompass people, technologies and services as the major components of information systems aiding synchronous and asynchronous teaching and learning in institution; (iv) the eLearning integration framework with three stages, i.e., before (feasibility study), during (learning process is executed) and after (test and evaluate performance) of eLearning systems; (v) a conceptual framework for social network to support collaborative learning (SSCL) comprises knowledge construction, a social network and concerned context as the main constructs feeding into the system; (vi) the framework for using social media in e-Learning explains three stages during which students are encouraged to engage in idea generation through the use of wikis and blogs, and then make sense of the content available as part of a problem-solving process for building knowledge, life experiences through collaboration, group discussions and other forms of learning. During this process, a student should be guided, supported and provided with a safe working environment; (vii) the social networking framework for learning motivation, which is a hybrid framework of mobile and web applications operating on a device although it can load data from external websites using hypertext transfer protocol (HTTP); (viii) collaborative e-learning, in which a learner is encouraged to assume responsibility for their learning through the constructivist approach using social networking tools to access blogs, discussion forums, chat rooms, file sharing, video conferencing, electronic portfolios and wikis—albeit with classmates and instructors present to assist; and (ix) the personalised and interactive web-based framework, integrating different environments to create an interactive learning environment by enhancing learner–learner and instructor–learner

interactions. The building blocks of these frameworks are humans, eLearning services and technology, each explained regarding how the block is related to it.

Chapter 5 introduced the formulation of the proposed framework guided by Dubin's theory-building method and the DSM development process adapted and modified to suit the development process of the framework devised in this study. The development of the framework was aided by the architecture of the conceptual framework as part of identifying the units of the framework and the use cases as a way to establish the laws of interaction that govern the theory; and also, the flow chart which determined the boundaries of the theory and then specified system states of the theory. The chapter detailed the development of the conceptual framework in stages, first presenting the peer-to-peer network, followed by the client-to-server network, and then leading to the hybrid framework as the proposed framework developed by this study. The study established the criteria for the framework validation for the experts to work from the same perspective when reviewing the framework. The study foresaw that the reviewers would scrutinise the framework for the first time and thus saw fit to provide them with a universal guide.

Chapter 6 constituted the seven components recommended by the research onion presented in Figure 6.1, i.e., the research philosophy, research approach, research methodology, research strategy, sampling techniques, data collection techniques and data analysis. The chapter explained the research philosophy as a set of beliefs about how data would be collected and analysed within a particular phenomenon; further, the chapter described four philosophical paradigms: positivism, critical realism constructivism and pragmatism. Thereafter, the chapter explained that pragmatism was selected because it allows flexibility of research by combining multiple methodologies that provide various angles of enquiry. The study applied the design science research approach since it primarily focuses on the development/design of artefacts, functional systems, architectures or frameworks. DSR is an outcome-based IS research methodology interested in providing frameworks and guidelines for evaluation in computer-based research projects; accordingly, Chapter 6 discussed the design science process model used as a guideline and aligned with the research study of this thesis. The chapter further described the mixed-methods methodology utilised, i.e., quantitative methods to collect data and qualitative methods to validate the quantitative output, and provided the justification for such methods. The chapter detailed the case study strategy consisting of a cluster of lecturers, students and administrators; random sampling was applied to each cluster, and purposive sampling explained how John Curry's rule of thumb guided the sample determination process. The data-gathering techniques were online questionnaires and expert reviews. Chapter 6 also addressed ethical considerations.

Chapter 7 presented data from three groups (students, lecturers and administrators) to answer the research questions presented in Chapter 1. The study needed to ascertain the types of SNSs accessed by students for general and educational reasons, as well as the benefits, disadvantages, differences and similarities of such SNSs, how to develop the framework, and the eLearning tools currently used by the

institution. The chapter presented the demographic data and response rates of each group and contained the execution of the reliability test. The chapter listed the statistical tests utilised, such as the Kolmogorov–Smirnov, Shapiro–Wilk and Kaiser–Meyer–Olkin (KMO) tests, Barlett's test of sphericity, Cronbach's alpha reliability test, factor analysis and hypothesis testing on the factors affecting SNS subscription. In this chapter, an exposition of the combined analyses of data from students, lecturers and administrators was provided and the average mean of the number of SNSs and features to be included from all three groups was determined.

Chapter 8 presented feedback from the expert reviewers and described its analysis based on the quality parameters set in Chapters 5 and 6, i.e., rigour and exactness, parsimony, completeness and logical flow or consistency. The validation of the model uncovered some weaknesses in the framework and served as a revelation of some of the aspects that had been bluntly omitted. Nevertheless, most of the feedback from experts was positive and approved of the framework's design. The contributions were grouped into two categories, functional and non-functional requirements. The functional requirements were the constructs added to the framework, and the non-functional requirements helped from the backend of the system. These contributions were aligned with the necessary literature before being fused.

Chapter 7 presented the results and Chapter 8 analysed and discussed the feedback; the extant literature was used to validate the results presented wherever any deviation was explained and supported categorically. Contributions regarded as valuable to the framework were added to the redesigned framework. Chapter 8 further presented the redesigned framework with minor changes since most of the elements had been validated by the experts, and such deviations were positively skewed to the non-functional elements.

9.3 Research Contributions

The research contribution is discussed as to the research output presented in this study as well as research papers resulting from this study. The third stage of the design science research process model has different activities, namely suggesting what the study could develop, synthesising and providing tentative design proposals, developing a system architecture, analysing and designing the system and lastly, building the system.

Contribution 1: The study identified a problem and suggested the solution of developing a framework to be used by universities as an eLearning tool, namely a federation of SNSs, after realising that the SNSs were fast becoming an effective and cheaper means of communication and transferring data. For example, in Zimbabwe, most students use their mobile phones for most of their school work. These smartphones are a competing substitute for a laptop since many applications for aiding in school work can be installed on a smartphone. If the students used SNSs as a learning tool, their learning would become more affordable in terms of cheaper devices; moreover, the data required for social networks are cheaper than general data (see Figure 9.1). This means a student might use around 4000 RTGS per

month instead of a compulsory amount of around 9000 RTGs per month for data to use on *Google Classroom* and other web-based eLearning services.

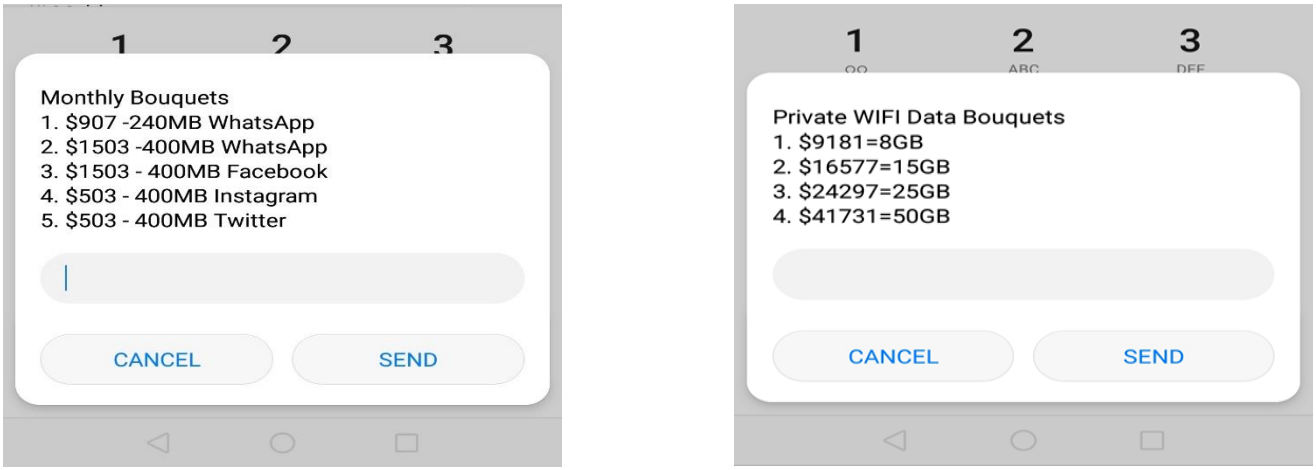


Figure 9.1: Comparison of SNS data bundles and general data prices. Source: Econet data prices (26/09/2022)

Contribution 2: In an attempt to synthesise the elements of the framework, the study undertook research on the different types of SNSs and their groups and sought to identify their similarities and differences from the extant literature, supported by the collected data, and examined the features, uses and architecture of each of the three most popular SNSs, i.e., Facebook, LinkedIn and YouTube. Readers of this part of the thesis would become well-versed with the structure of the SNSs they would be using and the features they should expect from those sites since the features that support teaching and learning were not omitted. This would increase confidence in choosing one of them or even subscribing to all of them.

Contribution 3: Several design proposals were suggested, the research output in the form of a paper was presented at the IST-Africa conference, and the peer-to-peer FSN framework and the client-to-server framework presented in Chapter 5 can be used by other learning institutions that might not necessarily require the entire hybrid framework. The peer-to-peer and client-to-server frameworks have intrinsic limitations, but their strengths were also discussed in Chapter 5; hence, another design proposal of the hybrid framework was introduced for users to have a variety of choices when choosing to implement one of these frameworks.

Contribution 4: In conjunction with developing the system architecture, the study presented a model within which the architecture can be developed, in Chapter 3; in Chapter 5, a model and use cases contributing to the development of framework architecture were presented. This informs users about the inner transmission of their data before it reaches the next recipient, and the use cases demonstrate the steps taken in making a request and processing the request and feedback or delivery achieved. This provides framework users and all others reading this thesis with the knowledge of how the SNSs were built and the activities involved besides those visible on the application layer, whereas the architecture demonstrates the arrangement of the actors, the stations involved and how they would interact.

Contribution 5: Analysing and designing the system, analysis of the findings, the models and use cases gathered to develop the framework and scrutinising the different architectures and frameworks. The different SNSs were characterised to supply the users of the system with detailed knowledge about how the different types of frameworks work and their advantages and disadvantages. The chapter described the different SNSs and their features, benefits and limitations; accordingly, the students are informed on the types to use or even become aware of the SNSs they are using.

Contribution 6: Building the system. After proposing the hybrid FSNS in Chapter 5, the data presented in Chapter 7 were analysed in Chapter 8. The constructed framework will be of great benefit to its users and other stakeholders. The hybrid FSNS has many benefits, of which some were adapted from the decentralised SNSs. The framework foresees a less costly eLearning tool considering that SNSs are cheaper means of communication and because students who cannot afford laptops can use their smartphones to access the tool. Another advantage is that the environment is familiar since most of the students are actively subscribed to one or more SNS; thus, little or no training is needed by new users. There is no need to be concerned about security issues since all SNSs have existing, robust security measures.

9.4 Conclusions

SNSs have become a common arena for many organisations in different forms, such as social, business or educational platforms. For that reason, social networking sites have increased, which has further contributed to a web experience paradigm shift from human-to-machine interfacing towards human-to-human interfacing. Social networking sites are regarded as online media platforms that create a virtual community for social communication, whereby groups are formed for family social interactions, church activities, some year school alumni interactions, interaction between fans of specific music and establishing businesses offering virtual sales; for instance, a business person could rent a small space while advertising many goods that might require several warehouses. Some groups are formed to sell and advertise; for example, a person starting up a small business like vending and educational objectives on SNSs where teachers conduct online lessons, including private tutorials, and established schools conducting extra lessons or holiday tutorials.

The same SNSs have shortcomings, such as social and network security, because information leakage through third-party applications can promote phishing, eavesdropping and hacking since users often load sensitive data, either intentionally or unintentionally. In legal and regulatory matters, SNSs can be used to perform a variety of activities that might be considered illegal, for example, online bullying, the theft of intellectual property, identity fraud, defamation of character, privacy infringements and slander. As regards specifications on information quality, some information posted on weblogs is not always reliable because most of these sites are open source, i.e., everyone is free to communicate their ideas and feelings. Furthermore, managing personal and professional time becomes a challenge when students spend more-and-more time on SNSs, engaging in activities unrelated to academic pursuits

because of the addictive nature of these networking sites. A lack of professionalism might arise because SNSs could reduce the way people respect or value each other due to a lack of physical connection.

The study provides a new perspective on SNSs to their users by turning most of their limitations into strengths by adapting much-loved SNSs towards becoming an eLearning tool. The environment they would be working in would be the same as their social environment, with the only difference being that they would be working on their academic activities. The FSNSs would enable students to log on to one SNS and communicate with other students or lecturers using the same or different SNS platform through the protocols allowing the SNSs to intercommunicate. The study unveiled the advantages of FSNs, including the promotion of educational freedom, their contribution to an information-rich community, their translation into advanced educational diversity, and discovery and innovation. In addition, users can freely choose how to learn and easily communicate across platforms regardless of their network providers as well as enhanced security features and enforcing a special degree of content management.

For the targeted users to be able to use the FSNSs eLearning tool, they should be subscribed to at least one SNSs, have a computer able to connect to the internet or a smartphone device of which the sim card provides a basic need since all network providers in the country are also internet service providers. These smartphones can also access the internet directly by tethering to a Wi-Fi hotspot, meaning that even without a sim card, they can access the internet. The costs related to the use of FSNSs do not go beyond the costs of using SNSs; the users simply need to buy data when registered to telecommunications networks such as Econet, Netone and Telecel or subscribed to other internet service providers such as Telone. Students can even work on assigned activities, discuss issues with fellow students and upload content, even without electricity (load-shedding[17]) since most devices have to be charged and used while on battery and can always be charged when regular electricity supply is restored.

In the process of developing the proposed FSNS framework, the study reviewed other eLearning frameworks by different authors. We anticipated such eLearning frameworks to shape the nature of framework development when combined with guidance from the theories discussed (the first part of Dubin's theory-building method's four-step process, namely the identification of units, the laws of interaction, determining boundaries, and identifying the system states) and other tools like use cases, flow diagrams and the model of the framework aided in developing the conceptual framework. Although we anticipate the study to be one of few studies investigating a federation of SNSs, the process highlighted earlier in this paragraph enables students to obtain sufficient background regarding the FSNSs eLearning tool they would be using.

[17] The shutdown of electricity supply, or power outage in particular areas for a specific time to enable fair distribution of electricity to different users.

Through its findings, this study proved that universities indeed work with SNSs for communication and even some other university-related activities, and provided the advantages of these academically related uses, recapped thus: were given (easy access to learning materials, facilitating easy two-way communication between the lecturers and students, students lacking confidence in asking questions in class and sharing ideas can do so freely, and playing video clips several times until better understanding of concepts.), signifying that the users are already amenable to using SNSs. This study converted the use of SNSs for academic reasons and produced a framework of requirements for the SNS eLearning model to be used in the form of a federation of SNSs. The SNSs are already used by lecturers, students and administrators; an eLearning model is also used in universities; hence, SNSs and the eLearning model should be combined to become one, stronger eLearning model.

9.5 Limitations

This study encountered some limitations. The quantitative data collection could not provide all the possible answers the participants could envisage since they had options derived from the literature review to choose from. Accordingly, the participants' requirements might not have been reflected. In addition, the study only carried out the quantitative data collection with students, lecturers and administrators but could not facilitate for focus groups from the same clusters to validate responses from questionnaires thereby relying only on experts' validation.

Most SNSs users do not feel free to provide facts considering that some are students and others (lecturers and administrators) are workers at the university, especially on the negativity of social networking and the frequency of use, because they fear losing contact with their preferred means of social interaction.

The study could not establish why the SNSs companies had not considered the federation of their SNSs, although some of them have partially federated with the SNSs that they had acquired in the past. The proposed framework requires SNSs to be interlinked for it to function as an FSNS eLearning tool.

The point raised above lead us to another limitation, the framework was developed entirely on the application of theoretical guidance from extant eLearning theories, literature on SNSs and framework/ model development theories only. The final framework was only improved by responses from the questionnaires before validated by Experts but was not tested to determine in any university system.

One university, the Midlands State University (MSU), was taken as the case study; accordingly, the results from the analysis of one university might not be sufficient to represent the situation in all universities in Zimbabwe. Some of the universities are specialised (like the National University of Science and Technology, Harare Institute of Technology and Chinhoyi University of Technology), and all universities seeking to embrace the federated SNS as an eLearning tool might not have the requisite processes and activities as MSU.

9.6 Recommendations

Considering that the contemporary way of communicating, teaching and learning is now mostly technology enhanced and more specifically internet enhanced. following this, the study thus devised some recommendations that can be taken into consideration by the stakeholders surrounding the use of FSNS4eL. this is done to enable the smooth uptake of the framework, reducing fear and phobia associated with change.

- The future of online learning is now; universities were forced to employ all the online tools at their disposal at the inception of the Covid-19 pandemic. This happened abruptly, causing many disadvantaged students to be left behind. The implementation of the federation of SNSs would need to be implemented in parallel with the eLearning modes already utilised; moreover, the university community should participate in the federated networking protocol development as the applications are expected to feature prominently in shaping the academic fraternity.

- Design and implementation of SNSs usage policies should be undertaken by universities to customise and promote these eLearning platforms for educational diversity purposes. One way to achieve that is by fully implementing control features on user application platforms to avoid the abuse of online activities and services.

- More investment into internetworking connectivity is required; this may involve mobile networking operators (MNOs) (of which these operators also believe in internetworking, as witnessed by their internetworking communication, including packages for off-net communications on their low-cost on-net bundles) to enhance eLearning connectivity aimed at benefiting all stakeholders, regardless of the place or geographical location in the country.

- Most universities are state-owned, and if faced with financial constraints in endeavouring to implement the federation of SNSs, they should seek government intervention or involve local and international nongovernmental organisations for aid with the implementation costs.

9.7 Future Study

Future work can be deduced from the limitations described in this chapter, and the stated contributions might need to be expanded to other areas of this study overall. Future work must be suggested since research, study and discovery is a continuous and infinite process, whereby the scholar can only investigate up to a certain point, and another scholar could continue or review and even correct the research for this study. The next sections group future work into three different categories:

9.7.1 Research at BSc Honours level

These are projects that could be conducted by students doing computer science and information system degrees. The projects or applications will be computer- or smartphone-based.

Research Topic 1: Campus-oriented P2P SNS.

This is a platform within which students can interact directly on campus. The application can be geographically locked to ensure that only students on that particular campus can log into the network. This is expected to prevent the use of subscribers' data by SNS operators without the subscribers' consent.

The objectives of the system include:

- End-to-end encryption of messages between participants.
- Accepting only students on the same campus through the use of geolocation.
- Allowing participants to control their data, be it location or storage.
- Minimising the risk of data breaches, where unauthorised users gain access to and convert data for various reasons.

Research Topic 2: Multiplatform compatibility of FSNSs.

This application would enable students and other users to use the platform with ease. Easier accessibility and availability is possible when the platform is compatible with all internet-enabled devices.

Objectives

- Switch between devices without data loss and waiting periods.
- Enable the application to operate on different operating systems and be compatible with different web browsers.
- Uncomplicated syncing when users move between devices.
- Data consistency is maintained across devices.

Research Topic 3: SNS hybrid application

The application enables users to communicate as if they were on the same platform; no boundaries owing to subscriptions to different SNSs. The application can be developed with open-source software to enable programmers to contribute to the improvement of the application.

Objectives

- To enable interoperability between different SNSs.
- Scalability and load balancing to support the growing number of users and their increasing data usage.
- To enable users' control over their data and the option of selecting their preferred server for hosting their data, which might increase a sense of privacy and ownership.

9.7.2 Possible research at a Master's level

This refers to advanced research attempting to solve bigger problems from a wider perspective. Master's degree research requires a detailed scope of frame, where problems described require the researchers to probe further and find permanent solutions with recommendations for further study.

Research Topic 1: Hybrid (P2P and client-server) FSNS4eL prototype.

This research would attempt to connect social networking users with eLearning as they would be interacting on the same platform, with every user logged into the SNSs of choice. The model enables users to control their data and privacy.

Objectives

Some of the objectives are:

- To enable the users to send and receive communication from different SNS platforms without difficulty.
- The system should be able to determine the type of data being requested and select the correct channel of transmission (p2p or client-server platform).
- Should be scaleable to accommodate a growing number of users and their data without compromising data quality and system performance.

Research Topic 2: FSNSs as tools for eLearning in Zimbabwean universities

Such research might need to include different universities, i.e., both technology-oriented and general universities, to obtain a true representation of the whole population in Zimbabwe instead of focusing on one university.

Objectives

- To establish what SNSs are used by different universities, students, lecturers and administrators.
- To suggest a developed FSNS4EL for scrutiny and validation through questionnaires.
- To evaluate and validate the proposed conceptual FSNS4eL and then deliver an improved version (if achieved) and recommend the framework for further adoption.

9.7.3 Research at PhD level.

Research at this level entails further engagement with the present study to gain more knowledge by expanding the scope of the research. Some ideas could arise from this research, which might be equally significant as this study, on a divergent area while maintaining the eLearning perspective.

Research Topic 1: **FSNS as a tool for eLearning in African universities**

Such a study would demand more perspective by including users from different cultures, languages and backgrounds. This might allow for a more improved framework that solves most problems related to SNSs in education. The framework could be customised after a final proposal has been recommended, or universities might choose to use it as is.

Objectives

- Establish the SNSs used by different universities, students, lecturers and administrators.

- Suggest a developed FSNS4EL for scrutiny, improvement and university customisation through questionnaires.
- Evaluate and validate the developed conceptual FSNS4eL and then deliver an improved version to different countries for further adoption.

Research Topic 2: Federation of eLearning platforms

Different types of eLearning platforms might need to be federated for scalability, interaction and data security and privacy. The study would entail the research to ascertain if these eLearning platforms were similar or, if not, how they differ by examining their features, capabilities and structures.

Objectives

- Conduct a comprehensive analysis of different eLearning platforms available in the literature.
- Study the different architectures of each eLearning platform, as well as their security mechanisms.
- Establish the strengths and weaknesses of each platform.
- Investigate the challenges and barriers that may hinder the implementation of a federation of eLearning platforms and how they could be managed.
- Design the federated eLearning platform to enable interoperability among eLearning platforms.
- Evaluate and validate the developed conceptual eLearning Framework and then deliver an improved version for further adoption.

Research Topic 3: Federation of universities' library platforms.

This would be a comprehensive resource-sharing platform with enhanced resource accessibility. The student or any library user might benefit from the initiative as the universities would complement each other in terms of resources, meaning the source required by users could be infinite, and user satisfaction would be improved.

Objectives

- Study the different architectures of each university library platform and their security mechanisms.
- Investigate the potential resource availability, accessibility and means of collaborating from different libraries.
- Design the federated university library platform to enable interoperability among university library platforms, facilitated by necessary authentication and authorisation strategies.

- Evaluate and validate the developed conceptual university library framework and then deliver an improved version for further adoption.

9.8 Summary

Chapter 9 concludes the study of the federation of social networking sites by summarising each chapter and indicating the chapters in which objectives stated in Chapter 1 had been considered and addressed. The chapter stated the study's contributions, discussed its conclusions and made recommendations and suggestions for further study. The chapter ends with the completion of the journey of the research study, which is intended to contribute positively to the academic body of knowledge.

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APPENDICES

APPENDIX 1: Students' questionnaires

PARTICIPANT INFORMATION SHEET

Ethics clearance reference number: 2020/CSET/SOC/018

Research permission reference number

13 September 2021

Title: Federated Social Networking Sites as a tool for eLearning in Zimbabwean Universities

Dear Prospective Participant

My name is Beauty Mugoniwa and I am doing research with Prof. E.N. Ketcha, a professor in School of Computing towards a PhD in Information Systems at the University of South Africa. We are inviting you to participate in a study entitled "Federation of Social Networking Sites as a tool for E-Learning: A case of Midlands State University in Zimbabwe". This study is expected to collect important information that could help to develop a SNSs federated framework which can be used as an eLearning tool by Zimbabwean Universities in the endeavour to reduce time spend by students on non-academic activities on the SNSs sites.

We have chosen you to participate in our study because you are the ones who are using social networking sites for teaching, learning and other communications in the institution. We requested for the permission to research at the university and were granted by the University Registrar. We are looking forward to have about 400 students, 300 lecturers and 52 administrators who will participate in the study. The study involves questionnaires to find out how networking sites are used, benefits of using them and types of social networking sites participants mostly use, personal identification is not required in the questionnaires. The participants are required to have completed answering the questionnaires in two weeks' time, to enable The study to have enough time to collect them and prepare them for data analysis.

Participating in this study is voluntary and you are under no obligation to consent to participation. If you do decide to take part, you will be given this information sheet to keep and be asked to sign a written consent form. You are free to withdraw at any time before you have submitted your questionnaire and without giving a reason but if you have already submitted, you will not be able to withdraw it.

We are expecting to develop an improved eLearning model which is accessible by most students and it is a cheaper online method of teaching and learning. The nature of our research does not anticipate any risks, because we are sending questionnaires online, no human interaction is required and no personal information is required. You have the right to insist that your name will not be recorder anywhere and that no one, apart from the researcher and identified members of the research team, will know about your involvement in this research and your name will not be recorded anywhere and no one will be able to connect you to the answers you give. Your answers will be given a code number or a pseudonym and you will be referred to in this way in the data and in the thesis report.

Your answers may be reviewed by people responsible for making sure that research is done properly, including members of the Research Ethics Review Committee. Otherwise, records that identify you will be available only to people working on the study, unless you give permission for other people to see the records. Part of the study data maybe produced in other publication, other than thesis report, but individual participation will not be identifiable in the report.

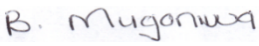
Information from data collection will be stored on a password protected computer. Future use of the stored data will be subject to further Research Ethics Review and approval if applicable. After 5 years of storing the data files from collected data will be overwritten to clear them using the right and effective software which will be available at that time, that is 5 years from now. No incentives are expected to be given for participants to participate in the study or after the study. No extra costs are expected to be incurred by the participants because they will be using already subscribed internet access to access the questionnaires and send them back.

This study has received written approval from the Research Ethics Review Committee of the School of Computing, Unisa. A copy of the approval letter can be obtained from the researcher if you so wish. If you would like to be informed of the final research findings, please contact Beauty Mugoniwa on 00263774016630 or mugoniwabm@gmail.com. Should you require any further information or want to contact the researcher about any aspect of this study, please contact Beauty Mugoniwa on 00263774016630 or mugoniwabm@gmail.com.

Should you have concerns about the way in which the research has been conducted, you may contact Prof. E.N. Ketcha on +27-(0)12-4296865, fax: +27-(0)12-4296848 or ngassek@unisa.ac.za. Contact the research ethics chairperson of the socethics@unisa.ac.za if you have any ethical concerns.

Thank you for taking time to read this information sheet and for participating in this study.

Thank you.



Beauty Mugoniwa

Part A: Demographics

1. Age: *Mark only one oval.*

- 22or less
- 23-27
- 28-32
- 33-37
- 38-42
- 43-53
- 54 or more

2. Gender: *Mark only one oval.*

- Female
- Male
- Prefer not to say

3. Marital status: *Mark only one oval.*

- Married Single
- Other

4. Degree being studied: Mark *only one oval.*

- Diploma
- Undergraduate
- Postgraduate diploma
- Masters
- PhD

5. Select your area of study *Mark only one oval.*

- Sciences
- Commercials
- Arts
- Education
- I.T

Part B: Social networking sites types, usage and benefits: In personal and educational Life

6. Are you a member of any social networking site?*Mark only one oval.*

- Yes
- No *Skip to question 18*
- Maybe

Subpart B: Social networking sites types, usage and benefits: In Personal and Educational

7. If yes/ maybe, please select all the social networking platforms that you use. *Check all that apply.*

- Facebook
- WhatsApp
- Twitter
- MySpace
- Linked In
- Sassai
- Instagram
- YouTube
- WeChat
- Messanger
- TikTok
- Telegram
- Pinterest SnapChat
- all of the above

8. How often do you access your social networking platform? * *Mark only one oval.*

- Daily
- Weekly
- Every two weeks
- Monthly
- Once in a while

9. How frequently do you use per your chosen time above? *Mark only one oval.*

- Less than 1 hour
- 1-2 hours
- 3-6 hours
- 7-8 hours
- More than 8 hours

10. Where do you access your internet? *Check all that apply.*

- [ ] On campus
- [ ] Internet café
- [ ] Home
- [ ] I move around with it.

11. Why do you use social networking sites in general? *Check all that apply.*

- [ ] Making new friends
- [ ] Maintaining the existing friends
- [ ] Keep in touch with friends and family
- [ ] Fun and entertainment

12. Why do you use social networking sites in your academic study? *Check all that apply.*

- [ ] Collaborate with other students
- [ ] To do research
- [ ] Send/receive mails to/from a colleague
- [ ] Sharing course materials
- [ ] A discussion space

13. Which social networking sites do you use for the reasons stated in (12) above?

Check all that apply.

- [ ] Facebook
- [ ] WhatsApp
- [ ] Twitter
- [ ] MySpace
- [ ] Linked In
- [ ] Sasai
- [ ] Instagram YouTube
- [ ] WeChat
- [ ] Messanger
- [ ] TikTok
- [ ] Telegram
- [ ] Pinterest SnapChat
- [ ] all of the above

14. Does your institution use these social networking sites when communicating with you? *Mark only one oval.*

- Yes
- No
- Maybe

15. Which platforms are used the most? *Check all that apply.*

- Facebook
- WhatsApp
- Twitter
- MySpace
- Linked In
- Sasai
- Instagram
- YouTube
- WeChat
- Messanger
- TikTok
- Telegram
- Pinterest SnapChat
- all of the above

16. What are these platforms used for? *Check all that apply.*

- Receiving learning materials
- Creating groups for group discussions
- Receiving announcements
- Submitting assignments and other tasks given.

Posting feedback on lessons learnt

17. What are the benefits of using such platforms *Check all that apply.*

- Ease access to learning materials.
- Facilitates an ease two why communication between the lecturers and students.
- Video clips can be played several times until one understands the concepts better.
- Those who lack confidence in asking questions in class and sharing their ideas, can do so freely.

Part C: Similarities and differences between the social networking platforms: Features and Uses of Social Networking Sites

Please tick the social networking site that is applicable to the social networking site * feature or use in grid 1 below. There are 14 social networking sites in the grid please scroll to view and check all that apply. Check at LEAST ONE COLUMN in each row, you may tick as many columns as possible.

Check all that apply.

	Facebook	WhatsApp	Twitter	MySpace	LinkedIn	Sassai	In
Channels for communication	☐	☐	☐	☐	☐	☐	
Disseminating of information	☐	☐	☐	☐	☐	☐	
Research	☐	☐	☐	☐	☐	☐	
Knowledge exchange	☐	☐	☐	☐	☐	☐	
Establishment of professional networking and making new contacts	☐	☐	☐	☐	☐	☐	
Encouraged interactivity in both peer and academic support	☐	☐	☐	☐	☐	☐	
Novel tools for teaching, learning, and enhancing educational interactions among peers, students, instructors, and preceptors	☐	☐	☐	☐	☐	☐	
Stay abreast of news and information pertaining to their professional interests by following or subscribing to updates in SNSs	☐	☐	☐	☐	☐	☐	
Enhanced the	☐	☐	☐	☐	☐	☐	

construction of students' own learning and the continuation of their engagement in development						
Photo album management	☐	☐	☐	☐	☐	☐
Classmates, friends and co-worker search engine	☐	☐	☐	☐	☐	☐
News feed	☐	☐	☐	☐	☐	☐
Timeline	☐	☐	☐	☐	☐	☐
Messaging	☐	☐	☐	☐	☐	☐
Customized Notifications	☐	☐	☐	☐	☐	☐
Live Streams	☐	☐	☐	☐	☐	☐
Flagging features	☐	☐	☐	☐	☐	☐
Customized Notifications	☐	☐	☐	☐	☐	☐
Recommendations	☐	☐	☐	☐	☐	☐
Participation	☐	☐	☐	☐	☐	☐
Profile management	☐	☐	☐	☐	☐	☐
Instant messaging facility	☐	☐	☐	☐	☐	☐
Ease of use	☐	☐	☐	☐	☐	☐
Advanced Search	☐	☐	☐	☐	☐	☐

Part D: How can Federated SNSs be used as an eLearning tool

18. Which social networking sites do you think should be incorporated in the framework? *Check all that apply.*

- [ ] Facebook
- [ ] WhatsApp
- [ ] Twitter
- [ ] MySpace
- [ ] Linked In
- [ ] Sasai
- [ ] Instagram
- [ ] YouTube
- [ ] WeChat
- [ ] Messanger TikTok
- [ ] Telegram
- [ ] Pinterest SnapChat
- [ ] all of the above

20. If we are to introduce a federated social networking site to use as an eLearning tool, select the services which should be included in the application layer. *Check all that apply.*

- [ ] Chats
- [ ] Jobs
- [ ] Calls
- [ ] Video
- [ ] Blogs
- [ ] SMS
- [ ] Voice notes
- [ ] Tags
- [ ] Comments
- [ ] Rating
- [ ] Uploading/ downloading content
- [ ] Search
- [ ] Request for a connection
- [ ] Discussion Forum

All of the above

21. From the grid 1 in part C above please select the features and uses which you think should be incorporated to make the site a useful eLearning platform. *Check all that apply.*

- [ ] Channels for communication
- [ ] Disseminating of information
- [ ] Research
- [ ] Knowledge exchange
- [ ] Establishment of professional networking and making new contacts
- [ ] Encouraged interactivity in both peer and academic support
- [ ] Novel tools for teaching, learning, and enhancing educational interactions among peers, students, instructors, and preceptors
- [ ] Stay abreast of news and information pertaining to their professional interests by following or subscribing to updates in SNSs
- [ ] Enhanced the construction of students' own learning and the continuation of their engagement in development
- [ ] Photo album management
- [ ] Classmates, friends and co-worker search engine
- [ ] News feed
- [ ] Timeline
- [ ] Messaging
- [ ] Customized Notifications
- [ ] Live Streams
- [ ] Flagging features
- [ ] Customized Notifications
- [ ] Recommendations
- [ ] Participation
- [ ] Pro le management
- [ ] Instant messaging facility
- [ ] Ease of use

Advanced Search

All of above

22. Considering the experiences, you have had while using the social networking sites for eLearning, the federated social networking platform will help you to

Check all that apply.

- [ ] Avoid spending too much time on un-educational materials during the studying hours.
- [ ] Be motivated to study by continuously being reminded of schoolwork by the federated social networking environment
- [ ] Learn without limits.
- [ ] Be content with the security of my data

23. Which eLearning model do you use at your institution, (that was developed by school or that was adopted)? *Mark only one oval.*

- ◯ Social networking based model
- ◯ General ICT based model

24. What are the functions of the eLearning model mentioned above? *Check all that apply.*

- [ ] Receiving course materials
- [ ] A discussion space with your facilitators
- [ ] An assessment feedback platform
- [ ] Notices platform

25. Is it compulsory to use the eLearning platform? *Mark only one oval.*

- ◯ Yes
- ◯ No
- ◯ Maybe

APPENDIX 2: Lecturer questionnaire

PARTICIPANT INFORMATION SHEET

Ethics clearance reference number: 2020/CSET/SOC/018

Research permission reference number

13 September 2021

Title: Federated Social Networking Sites as a tool for eLearning in Zimbabwean Universities

Dear Prospective Participant

My name is Beauty Mugoniwa and I am doing research with Prof. E.N. Ketcha, a professor in School of Computing towards a PhD in Information Systems at the University of South Africa. We are inviting you to participate in a study entitled "Federation of Social Networking Sites as a tool for eLearning: A case of Midlands State University in Zimbabwe". This study is expected to collect important information that could help to develop a SNSs federated framework which can be used as an eLearning tool by Zimbabwean Universities in the endeavour to reduce time spend by students on non-academic activities on the SNSs sites.

We have chosen you to participate in our study because you are the ones who are using social networking sites for teaching, learning and other communications in the institution. We requested for the permission to research at the university and were granted by the University Registrar. We are looking forward to have about 400 students, 300 lecturers and 52 administrators who will participate in the study. The study involves questionnaires to find out how networking sites are used, benefits of using them and types of social networking sites participants mostly use, personal identification is not required in the questionnaires. The participants are required to have completed answering the questionnaires in two weeks' time, to enable The study to have enough time to collect them and prepare them for data analysis.

Participating in this study is voluntary and you are under no obligation to consent to participation. If you do decide to take part, you will be given this information sheet to keep and be asked to sign a written consent form. You are free to withdraw at any time before you have submitted your

questionnaire and without giving a reason but if you have already submitted, you will not be able to withdraw it.

We are expecting to develop an improved eLearning model which is accessible by most students and it is a cheaper online method of teaching and learning. The nature of our research does not anticipate any risks, because we are sending questionnaires online, no human interaction is required and no personal information is required. You have the right to insist that your name will not be recorder anywhere and that no one, apart from the researcher and identified members of the research team, will know about your involvement in this research and your name will not be recorded anywhere and no one will be able to connect you to the answers you give. Your answers will be given a code number or a pseudonym and you will be referred to in this way in the data and in the thesis report.

Your answers may be reviewed by people responsible for making sure that research is done properly, including members of the Research Ethics Review Committee. Otherwise, records that identify you will be available only to people working on the study, unless you give permission for other people to see the records. Part of the study data maybe produced in other publication, other than thesis report, but individual participation will not be identifiable in the report.

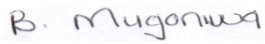
Information from data collection will be stored on a password protected computer. Future use of the stored data will be subject to further Research Ethics Review and approval if applicable. After 5 years of storing the data files from collected data will be overwritten to clear them using the right and effective software which will be available at that time, that is 5 years from now. No incentives are expected to be given for participants to participate in the study or after the study. No extra costs are expected to be incurred by the participants because they will be using already subscribed internet access to access the questionnaires and send them back.

This study has received written approval from the Research Ethics Review Committee of the School of Computing, Unisa. A copy of the approval letter can be obtained from the researcher if you so wish. If you would like to be informed of the final research findings, please contact Beauty Mugoniwa on 00263774016630 or mugoniwabm@gmail.com. Should you require any further information or want to contact the researcher about any aspect of this study, please contact Beauty Mugoniwa on 00263774016630 or mugoniwabm@gmail.com.

Should you have concerns about the way in which the research has been conducted, you may contact Prof. E.N. Ketcha on +27-(0)12-4296865, fax: +27-(0)12-4296848 or ngassek@unisa.ac.za. Contact the research ethics chairperson of the socethics@unisa.ac.za if you have any ethical concerns.

Thank you for taking time to read this information sheet and for participating in this study.

Thank you.



Beauty Mugoniwa

Part A: Demographics

1. Age: *Mark only one oval.*

- [ ] 30 or less
- [ ] 31-40
- [ ] 41-50
- [ ] 51-60
- [ ] 61-70

2. Gender: *Mark only one oval.*

- [ ] Female
- [ ] Male
- [ ] Prefer not to say

3. Marital status:*Mark only one oval.*

- [ ] Married
- [ ] Single
- [ ] Other

4. Educational Level: *Mark only one oval.*

- [ ] Postgraduate diploma
- [ ] Masters
- [ ] PHd
- [ ] Other:

5. Select your area of specialisation. *Mark only one oval.*

- [ ] Sciences
- [ ] Commercials
- [ ] Arts
- [ ] Education
- [ ] I.T
- [ ] other

Part B: Social networking sites types, usage and benefits in Personal and Educational Life

6. Are you a member of any social networking site? Mark only one oval.

- [ ] Yes
- [ ] No *Skip to question 21*
- [ ]

Maybe

Sub Part B: Social networking sites types, usage and benefits: In Personal and Educational Life

6. If yes/ maybe please select all the social networking platforms that you use.

Check all that apply.

- [ ] Facebook
- [ ] WhatsApp
- [ ] Twitter
- [ ] MySpace
- [ ] Linked In
- [ ] Sassai
- [ ] Instagram
- [ ] YouTube
- [ ] WeChat
- [ ] Messanger
- [ ] TikTok
- [ ] Telegram
- [ ] Pinterest SnapChat

all of the above

8. How do you view the use of social networking sites in eLearning ?

Check all that apply.

- [ ] Helps the students to understand better.
- [ ] Motivates the students to have open discussions
- [ ] Hinders the students in concentrating in school issues Gives the students unnecessary freedom than recommended

Other:

9. How often do you access your social networking platform? *Mark only one oval.*

- ◯ Daily
- ◯ Weekly
- ◯ Every two weeks
- ◯ Monthly
- ◯ Once in a while

10. How frequently do you use per your chosen time above? *Mark only one oval.*

- Less than 1 hour
- 1-2 hours
- 3-6 hours
- 7-8 hours
- More than 8 hours

11. Where do you access your internet? *Check all that apply.*

- On campus
- Internet café
- Home

I move around with it.

12. Why do you use social networking sites in general? *Check all that apply.*

- Making new friends
- Maintaining the existing friends
- Keep in touch with friends and family

Fun and entertainment

13. Why do you use social networking sites in your academic study? *Check all that apply.*

- Collaborate with other staff
- To do research
- Send/receive mails to/from a colleague posting
- course materials A discussion space

14. Which social networking sites do you use for the reasons stated in (12) above? *Check all that apply.*

- Facebook
- WhatsApp
- Twitter
- MySpace
- Linked In
- Sassai
- Instagram
- YouTube
- WeChat
- Messenger
- TikTok

Telegram

Pinterest SnapChat

all of the above

15. Does your institution use these social networking sites when communicating with you? *Mark only one oval.*

- ◯ Yes
- ◯ No
- ◯ Maybe

16. Which platforms are used the most? *Check all that apply.*

- ☐ Facebook
- ☐ WhatsApp
- ☐ Twitter
- ☐ MySpace
- ☐ Linked In
- ☐ Sasai
- ☐ Instagram
- ☐ YouTube
- ☐ WeChat
- ☐ Messanger
- ☐ TikTok
- ☐ Telegram
- ☐ Pinterest SnapChat
- ☐ all of the above

17. What are these platforms used for? *Check all that apply.*

- ☐ Sending learning materials
- ☐ Creating groups for group discussions posting announcements receiving assignments and other work assigned to students.
- ☐ Receiving feedback on lessons learnt

18. What are the benefits of using such platforms Check all that apply.*Check all that apply.*

- ☐ Ease conveyance of messages.
- ☐ Facilitates an ease two why communication between the lecturers and students.
- ☐ Everyone is member of at least one social networking platform, so messages are guaranteed to reach the intended recipients.
- ☐ It is cheaper means of communicating.

19. Do the students give feedback using the platforms? *Mark only one oval.*

- Yes
- Most of them just respond by doing what is asked of them
- no

Part C: Similarities and differences between the social networking platforms: Features and Uses of Social Networking Sites

19. Please tick the social networking site that is applicable to the social networking site feature or use in grid 1 below. There are 14 social networking sites in the grid please scroll to view and check all that apply. Check at LEAST ONE COLUMN in each row, you may tick as many

columns as possible
Check all that apply.

	Facebook	WhatsApp	Twitter	MySpace	LinkedIn	Sassai	In
Channels for communication	☐	☐	☐	☐	☐	☐	
Disseminating of information	☐	☐	☐	☐	☐	☐	
Research	☐	☐	☐	☐	☐	☐	
Knowledge exchange	☐	☐	☐	☐	☐	☐	
Establishment of professional networking and making new contacts	☐	☐	☐	☐	☐	☐	
Encouraged interactivity in both peer and academic support	☐	☐	☐	☐	☐	☐	
Novel tools for teaching, learning, and enhancing educational interactions among peers, students, instructors, and preceptors	☐	☐	☐	☐	☐	☐	
Stay abreast of news and information pertaining to their professional interests by following or subscribing to updates in SNSs	☐	☐	☐	☐	☐	☐	
Enhanced the	☐	☐	☐	☐	☐	☐	

construction of students' own learning and the continuation of their engagement in development						
Photo album management	☐	☐	☐	☐	☐	☐
Classmates, friends and co-worker search engine	☐	☐	☐	☐	☐	☐
News feed	☐	☐	☐	☐	☐	☐
Timeline	☐	☐	☐	☐	☐	☐
Messaging	☐	☐	☐	☐	☐	☐
Customized Notifications	☐	☐	☐	☐	☐	☐
Live Streams	☐	☐	☐	☐	☐	☐
Flagging features	☐	☐	☐	☐	☐	☐
Recommendations	☐	☐	☐	☐	☐	☐
Participation	☐	☐	☐	☐	☐	☐
Profile management	☐	☐	☐	☐	☐	☐
Instant messaging facility	☐	☐	☐	☐	☐	☐
Ease of use	☐	☐	☐	☐	☐	☐
Advanced Search	☐	☐	☐	☐	☐	☐

Part D: How can Federated SNSs be used as an eLearning tool

20. Which social networking sites do you think should be incorporated in the framework? *Check all that apply.*

- [ ] Facebook
- [ ] WhatsApp
- [ ] Twitter
- [ ] MySpace
- [ ] Linked In
- [ ] Sassai
- [ ] Instagram
- [ ] YouTube
- [ ] WeChat
- [ ] Messenger
- [ ] TikTok
- [ ] Telegram

Pinterest SnapChat

all of the above

22. If we are to introduce a federated social networking site to use as an eLearning tool, select the services which should be included in the application layer. *Check all that apply.*

- [ ] Chats
- [ ] Jobs
- [ ] Calls
- [ ] Video
- [ ] Blogs
- [ ] SMS
- [ ] Voice notes
- [ ] Tags
- [ ] Comments
- [ ] Rating
- [ ] Uploading/ downloading content
- [ ] Search

Request for a connection

Discussion Forum

All of the above

23. From the grid 1 in part C above please select the features and uses which you think should be incorporated to make the site a useful eLearning platform. *Check all that apply.*

- [ ] Channels for communication
- [ ] Disseminating of information
- [ ] Research
- [ ] Knowledge exchange
- [ ] Establishment of professional networking and making new contacts
- [ ] Encouraged interactivity in both peer and academic support
- [ ] Novel tools for teaching, learning, and enhancing educational interactions among peers, students, instructors, and preceptors
- [ ] Stay abreast of news and information pertaining to their professional interests by following or subscribing to updates in SNSs
- [ ] Enhanced the construction of students' own learning and the continuation of their engagement in development
- [ ] Photo album management
- [ ] Classmates, friends and co-worker search engine
- [ ] News feed
- [ ] Timeline
- [ ] Messaging
- [ ] Customised notifications
- [ ] Live Streams
- [ ] Flagging features
- [ ] Recommendations
- [ ] Participation

Pro le management

Instant messaging facility

Ease of use

Advanced Search

All of above

24. Which eLearning model do you use at your institution, (that was developed by school or that was adopted)? *Mark only one oval.*

- Social networking based model
- General ICT based model

25. What are the functions of the eLearning model mentioned above? Check all that apply. *Check all that apply.*

- Giving course materials
- A discussion space with students
- An assessment platform

Notices platform

26. Is it compulsory to use the eLearning platform? *Mark only one oval.*

- Yes
- No
- Maybe

APPENDIX 3: Administrators' questionnaire

PARTICIPANT INFORMATION SHEET

Ethics clearance reference number: 2020/CSET/SOC/018

Research permission reference number

13 September 2021

Title: Federated Social Networking Sites as a tool for eLearning in Zimbabwean Universities

Dear Prospective Participant

My name is Beauty Mugoniwa and I am doing research with Prof. E.N. Ketcha, a professor in School of Computing towards a PhD in Information Systems at the University of South Africa. We are inviting you to participate in a study entitled "Federation of Social Networking Sites as a tool for E-Learning: A case of Midlands State University in Zimbabwe". This study is expected to collect important information that could help to develop a SNSs federated framework which can be used as an eLearning tool by Zimbabwean Universities in the endeavour to reduce time spend by students on non-academic activities on the SNSs sites.

We have chosen you to participate in our study because you are the ones who are using social networking sites for teaching, learning and other communications in the institution. We requested for the permission to research at the university and were granted by the University Registrar. We are looking forward to have about 400 students, 300 lecturers and 52 administrators who will participate in the study. The study involves questionnaires to find out how networking sites are used, benefits of using them and types of social networking sites participants mostly use, personal identification is not required in the questionnaires. The participants are required to have completed answering the questionnaires in two weeks' time, to enable The study to have enough time to collect them and prepare them for data analysis.

Participating in this study is voluntary and you are under no obligation to consent to participation. If you do decide to take part, you will be given this information sheet to keep

and be asked to sign a written consent form. You are free to withdraw at any time before you have submitted your questionnaire and without giving a reason but if you have already submitted, you will not be able to withdraw it.

We are expecting to develop an improved eLearning model which is accessible by most students and it is a cheaper online method of teaching and learning. The nature of our research does not anticipate any risks, because we are sending questionnaires online, no human interaction is required and no personal information is required. You have the right to insist that your name will not be recorder anywhere and that no one, apart from the researcher and identified members of the research team, will know about your involvement in this research and your name will not be recorded anywhere and no one will be able to connect you to the answers you give. Your answers will be given a code number or a pseudonym and you will be referred to in this way in the data and in the thesis report.

Your answers may be reviewed by people responsible for making sure that research is done properly, including members of the Research Ethics Review Committee. Otherwise, records that identify you will be available only to people working on the study, unless you give permission for other people to see the records. Part of the study data maybe produced in other publication, other than thesis report, but individual participation will not be identifiable in the report.

Information from data collection will be stored on a password protected computer. Future use of the stored data will be subject to further Research Ethics Review and approval if applicable. After 5 years of storing the data files from collected data will be overwritten to clear them using the right and effective software which will be available at that time, that is 5 years from now. No incentives are expected to be given for participants to participate in the study or after the study. No extra costs are expected to be incurred by the participants because they will be using already subscribed internet access to access the questionnaires and send them back.

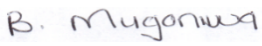
This study has received written approval from the Research Ethics Review Committee of the School of Computing, Unisa. A copy of the approval letter can be obtained from the researcher if you so wish. If you would like to be informed of the final research findings, please contact Beauty Mugoniwa on 00263774016630 or mugoniwabm@gmail.com. Should you require any further information or want to contact the researcher about any aspect of this study, please contact Beauty Mugoniwa on 00263774016630 or mugoniwabm@gmail.com.

Should you have concerns about the way in which the research has been conducted, you may contact Prof. E.N. Ketcha on +27-(0)12-4296865, fax: +27-(0)12-4296848 or

ngassek@unisa.ac.za. Contact the research ethics chairperson of the socethics@unisa.ac.za if you have any ethical concerns.

Thank you for taking time to read this information sheet and for participating in this study.

Thank you.



Beauty Mugoniwa

Part A: Demographics Section

1. Age: *Mark only one oval.*
   - ◯ 30 or less
   - ◯ 31-40
   - ◯ 41-50
   - ◯ 51-60
   - ◯ 61or more
2. Gender: *Mark only one oval.*
   - ◯ Female
   - ◯ Male
   - ◯ Prefer not to say
3. Marital status: *Mark only one oval.*
   - ◯ Married
   - ◯ Single
   - ◯ Other
4. Educational Level *Mark only one oval.*
   - ◯ Undergraduate degree
   - ◯ Postgraduate degree
   - ◯ Masters
   - ◯ PhD
   - ◯ Other
5. Select your area of specialisation. *Mark only one oval.*

- Sciences
- Commercials
- Arts
- Education
- I.T
- Other

Part B: Social networking sites types, usage and benefits: In Personal and Educational Life

6. Are you a member of any social networking site? *Mark only one oval.*

- Yes
- No *Skip to question 17*
- Maybe

SubPart B: Social networking sites types, usage and benefits: In Personal and Educational Life

7. If yes/ maybe please select all the social networking platforms that you use. *Check all that apply.*

- [ ] Facebook
- [ ] WhatsApp
- [ ] Twitter
- [ ] MySpace
- [ ] Linked In
- [ ] Sassai
- [ ] Instagram
- [ ] YouTube
- [ ] WeChat
- [ ] Messanger
- [ ] TikTok
- [ ] Telegram
- [ ] Pinterest
- [ ] SnapChat

all of the above

8. How often do you access your social networking platform? *Mark only one oval.*

- Daily
- Weekly
- Every two weeks
- Monthly
- Once in a while

9. How frequently do you use per your chosen time above? *Mark only one oval.*

- Less than 1 hour
- 1-2 hours
- 3-6 hours
- 7-8 hours
- More than 8 hours

10. Where do you access your internet? *Check all that apply.*

- On campus
- Internet café
- Home
- I move around with it.

11. Why do you use social networking sites in general? *Check all that apply.*

- Making new friends
- Maintaining the existing friends
- Keep in touch with friends and family
- Fun and entertainment

12. Does your institution use these social networking sites when communicating with you: Mark *only one oval.*

- Yes
- No
- Maybe

13. Which platforms are used the most? *Check all that apply.*

- [ ] Facebook
- [ ] WhatsApp
- [ ] Twitter
- [ ] MySpace
- [ ] Linked In
- [ ] Sasai
- [ ] Instagram
- [ ] YouTube
- [ ] WeChat
- [ ] Messanger
- [ ] TikTok
- [ ] Telegram
- [ ] Pinterest SnapChat

all of the above

14. What are these platforms used for? *Check all that apply.*

- [ ] posting announcements Receiving
- [ ] feedback from students

15. What are the benefits of using such platforms *Check all that apply.*

- [ ] Ease conveyance of messages.
- [ ] Facilitates an ease two why communication between the administrators and students.
- [ ] Everyone is member of at least one social networking platform, so messages are guaranteed to reach the intended recipients.
- [ ] It is a cheaper means of communicating.

16. Do the students give feedback using the platforms? *Mark only one oval.*

- ◯ Yes
- ◯ Most of them just respond by doing what is asked of them no
- ◯

Part C: Similarities and differences between the social networking platforms:

Features and Uses of Social Networking Sites

17. Please tick the social networking site that is applicable to the social networking site, feature or use in grid 1 below. There are 14 social networking sites in the grid please scroll to view and check all that apply. Check at LEAST ONE COLUMN in each row, you may tick as many columns as possible

Check all that apply.

	Facebook	WhatsApp	Twitter	MySpace	LinkedIn	Sassai	In
Channels for communication	☐	☐	☐	☐	☐	☐	
Disseminating of information	☐	☐	☐	☐	☐	☐	
Research	☐	☐	☐	☐	☐	☐	
Knowledge exchange	☐	☐	☐	☐	☐	☐	
Establishment of professional networking and making new contacts	☐	☐	☐	☐	☐	☐	
Encouraged interactivity in both peer and academic support	☐	☐	☐	☐	☐	☐	
Novel tools for teaching, learning, and enhancing educational interactions among peers, students, instructors, and preceptors	☐	☐	☐	☐	☐	☐	
Stay abreast of news and information pertaining to their professional interests by following or subscribing to updates in SNSs	☐	☐	☐	☐	☐	☐	
Enhanced the professional networking and making new	☐	☐	☐	☐	☐	☐	
Enhanced the	☐	☐	☐	☐	☐	☐	

construction of students' own learning and the continuation of their engagement in development						
Photo album management	☐	☐	☐	☐	☐	☐
Classmates, friends and co-worker search engine	☐	☐	☐	☐	☐	☐
News feed	☐	☐	☐	☐	☐	☐
Timeline	☐	☐	☐	☐	☐	☐
Messaging	☐	☐	☐	☐	☐	☐
Customized Notifications	☐	☐	☐	☐	☐	☐
Live Streams	☐	☐	☐	☐	☐	☐
Flagging features	☐	☐	☐	☐	☐	☐
Customized Notifications	☐	☐	☐	☐	☐	☐
Recommendations	☐	☐	☐	☐	☐	☐
Participation	☐	☐	☐	☐	☐	☐
Profile management	☐	☐	☐	☐	☐	☐
Instant messaging facility	☐	☐	☐	☐	☐	☐
Ease of use	☐	☐	☐	☐	☐	☐
Advanced Search	☐	☐	☐	☐	☐	☐

Part D: How can Federated SNSs be used as an eLearning tool

18. Which social networking sites do you think should be incorporated in the framework? *Check all that apply.*

- [ ] Facebook
- [ ] WhatsApp
- [ ] Twitter
- [ ] MySpace
- [ ] Linked In
- [ ] Sasai
- [ ] Instagram
- [ ] YouTube
- [ ] WeChat
- [ ] Messanger
- [ ] TikTok
- [ ] Telegram
- [ ] Pinterest SnapChat
- [ ] all of the above

19. If we are to introduce a federated social networking site to use as an eLearning tool, select the services which should be included in the application layer. *Check all that apply.*

- [ ] Chats
- [ ] Jobs
- [ ] Calls
- [ ] Video
- [ ] Blogs
- [ ] SMS
- [ ] Voice notes
- [ ] Tags
- [ ] Comments
- [ ] Rating
- [ ] Uploading/ downloading content
- [ ] Search
- [ ] Request for a connection
- [ ] Discussion Forum
- [ ] All of the above

20. From the grid 1 in part C above please select the features and uses which you think should be incorporated to make the site a useful eLearning platform. *Check all that apply.*

- [ ] Channels for communication
- [ ] Disseminating of information
- [ ] Research
- [ ] Knowledge exchange
- [ ] Establishment of professional networking and making new contacts
- [ ] Encouraged interactivity in both peer and academic support
- [ ] Novel tools for teaching, learning, and enhancing educational interactions among peers, students, instructors, and preceptors
- [ ] Stay abreast of news and information pertaining to their professional interests by following or subscribing to updates in SNSs
- [ ] Enhanced the construction of students' own learning and the continuation of their engagement in development
- [ ] Photo album management
- [ ] Classmates, friends and co-worker search engine
- [ ] News feed
- [ ] Timeline
- [ ] Messaging
- [ ] Customised notifications
- [ ] Live Streams
- [ ] Flagging features
- [ ] Recommendations
- [ ] Participation
- [ ] Profile management
- [ ] Instant messaging facility
- [ ] Ease of use

Advanced Search

All of above

21. Which eLearning model do you use at your institution, (that was developed by school or that was adopted)? *Mark only one oval.*

- ◯ Social networking based model
- ◯ General ICT based model

22. What are the functions of the eLearning model mentioned above? *Check all that apply.*

- ☐ Feedback from students
- ☐ Notices platform

23. Is it compulsory to use the eLearning platform? *Mark only one oval.*

- ◯ Yes
- ◯ No
- ◯ Maybe

APPENDIX 4: Data Analysis tables

Table A. 1 :Characteristics /features/uses of SNSs

	Facebook	WhatsApp	Twitter	MySpace	LinkedIn	Sassai	Instagram	YouTube	WeChat	Messenger	TikTok	Telegram	Pinterest	SnapChat	Neutral
CH	114	283	34	11	9	12	24	14	12	21	5	10	5	10	8
DI	119	238	27	4	13	6	12	22	6	11	2	6	3	4	9
RE	106	148	15	8	24	5	5	72	1	3	0	5	11	1	17
KE	100	248	22	10	11	4	9	36	10	10	3	12	11	3	10
PN	134	207	42	9	38	4	18	13	8	7	4	9	7	3	9
EI	116	243	24	5	16	5	19	23	5	11	3	8	4	5	11
NI	107	218	25	8	14	5	8	29	6	6	3	4	8	1	13
SA	158	179	25	5	19	2	9	29	2	5	1	5	6	0	0
EC	113	212	14	8	14	7	8	27	3	7	2	5	5	2	13
PM	174	146	19	7	3	4	27	14	2	1	4	2	7	13	10
SE	133	184	23	9	13	3	12	26	2	4	2	4	5	4	12
NF	164	160	45	10	16	9	13	22	2	4	4	2	3	3	11
TM	177	143	26	9	15	6	20	13	2	3	4	6	2	2	11
MS	110	260	32	8	11	9	16	6	5	12	5	7	2	3	10
CN	157	187	30	8	11	5	15	10	2	5	4	4	3	1	10
LS	170	128	26	11	9	8	25	32	3	2	3	4	1	2	12
FF	154	148	26	9	10	4	15	22	3	3	2	2	2	1	14
RC	143	184	25	8	9	8	15	11	3	4	3	3	2	3	13
PT	110	234	27	8	13	3	11	13	2	3	4	4	2	2	12
PR	162	179	27	10	19	4	14	7	2	1	4	4	1	3	13
IM	89	256	27	7	11	5	11	7	3	2	3	1	0	3	10
ES	91	252	25	11	8	8	11	12	5	4	5	3	2	2	11
AS	142	138	29	17	18	7	11	31	6	1	2	2	4	3	14

Source: Primary Data, 2021

Table A. 2: Key to the Characteristics/Features/Uses of SNSs

Key	Characteristics/features/uses	Key	Characteristics/features/uses
CH(L)	Channels for communication	NF(L)	News feed
DI(L)	Disseminating of information	MS(L)	Messaging
RE(L)	Research	CN(L)	Customized Notifications
KN(L)	Knowledge exchange	LS(L)	Live Streams
RC(L)	Recommendations	AS(L)	Advanced Search
PT(L)	Participation	PM(L)	Photo album management
PR(L)	Profile management	TM(L)	Timeline
IM(L)	Instant messaging facility	FF(L)	Flagging features
EU(L)	Ease of use	AL(L)	All
PN(L)	Establishment of professional networking and making new contacts		
EI(L)	Encouraged interactivity in both peer and academic support		
NT(L)	Novel tools for teaching, learning, and enhancing educational interactions among peers, students, instructors, and preceptors		
SA(L)	Stay abreast of news and information pertaining to their professional interests by following or subscribing to updates in SNSs		
EC(L)	Enhanced the construction of students' own learning and the continuation of their engagement in development		
CS(L)	Classmates, friends and co-worker search engine		

Table A. 3: Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Gender	89.77	675.418	.029	.936
Marital Status	90.00	677.408	-.051	.937
Degree being studied	87.35	675.964	.006	.937
Area of study	88.17	673.807	.034	.937
SNSs Member	89.11	677.325	.001	.936
Frequency of use	89.76	681.963	-.117	.939
Hours Spent	88.75	665.243	.164	.937
eLearning Model used	89.55	677.357	-.047	.937
Compulsory eLearning	89.17	674.789	.065	.936

Source: Primary Data, 2021

Table A. 4: Correlation of Variables

Correlations					
Spearman's rho		Age	Gender	Area of study	SNSs Member
Age	Correlation Coefficient	1.000	-.107	-.182**	.090
	Sig. (2-tailed)	.	.056	.001	.110
	N	316	316	316	316
Gender	Correlation Coefficient	-.107	1.000	.221**	.017
	Sig. (2-tailed)	.056	.	.000	.761
	N	316	316	316	316
Area of study	Correlation Coefficient	-.182**	.221**	1.000	-.056
	Sig. (2-tailed)	.001	.000	.	.323
	N	316	316	316	316
SNSs Member	Correlation Coefficient	**.090**	**.017**	**-.056**	1.000
	Sig. (2-tailed)	.110	.761	.323	.
	N	316	316	316	316
**. Correlation is significant at the 0.01 level (2-tailed).					

Source: Primary Data, 2021

Table A. 5: Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of	Cumulative	Total	% of Variance	Cumulative	Total	% of Variance	Cumulative
1	12.119	52.690	52.690	12.119	52.690	52.690	7.346	31.939	31.939
2	1.609	7.994	59.684	1.609	7.994	59.684	4.639	20.168	52.106
3	1.002	4.358	64.042	1.002	4.358	64.042	2.745	11.936	64.042
4	.865	3.761	67.803						
5	.808	3.514	71.317						
6	.693	3.014	74.331						
7	.599	2.605	77.936						
8	.546	2.372	79.308						
9	.510	2.218	81.526						
10	.477	2.074	83.599						
11	.462	2.007	85.606						
12	.425	1.847	87.452						
13	.375	1.630	89.083						
14	.337	1.465	90.548						
15	.321	1.394	91.942						
16	.310	1.350	93.292						
17	.282	1.227	94.519						
18	.272	1.181	95.699						
19	.259	1.128	97.827						
20	.217	.942	97.769						
21	.206	.895	98.665						
22	.171	.742	99.407						
23	.136	.593	100.000						
Extraction Method: Principal Component Analysis.									

Source: Primary Data, 2021

Table A. 6: Rotated Component Matrix

Rotated Component Matrix[a]				
		Component		
		1	2	3
RC	Recommendations	.731		
AS	Advanced Search	.718		
MS	Messaging	.711		
EC	Enhanced the construction of students' own learning and the continuation of their engagement in development	.698		
IM	Instant messaging facility	.690		
NT	Novel tools for teaching, learning, and enhancing educational interactions among peers, students, instructors, and preceptors	.687		
SA	Stay abreast of news and information pertaining to their professional interests by following or subscribing to updates in SNSs	.686		
EU	Ease of use	.685		
PT	Participation	.670		
LS	Live Streams	.666		
PR	Profile management	.652		
NF	News feed	.640		
CN	Customized Notifications	.595		
CS	Classmates, friends and co-worker search engine	.585		
KN	Knowledge exchange		.798	
RE	Research		.793	
DI	Disseminating of information		.782	
CH	Channels for communication		.751	
PN	Establishment of professional networking and making new contacts		.578	
EI	Encouraged interactivity in both peer and academic support		.552	
PM	Photo album management			.816
FF	Flagging features			.723
TM	Timeline			.628

Extraction Method: Principal Component Analysis.

a. Rotation converged in 6 iterations.

Source: Primary Data, 2021

Table A. 7: Characteristics/features/uses of SNSs

	Facebook	WhatsApp	Twitter	MySpace	LinkedIn	Sasai	Instagram	YouTube	WeChat	Messenger	TikTok	Telegram	Pinterest	SnapChat	Neutral
CH	83	142	27	4	12	4	10	9	3	15	1	6	1	3	4
DI	79	130	30	3	10	3	6	14	5	5	3	5	4	2	6
RE	55	54	20	6	27	1	3	43	2	2	0	3	4	2	16
KE	69	115	29	6	26	2	7	13	7	6	2	8	2	2	10
PN	74	81	21	7	48	4	4	7	2	2	1	3	3	1	7
EI	67	114	26	8	31	8	7	10	3	8	2	5	3	2	7
NT	68	107	16	7	17	4	4	22	3	4	3	6	3	1	9
SA	79	79	28	8	28	4	5	23	4	4	1	5	3	2	10
EC	73	92	19	10	16	2	4	18	2	4	2	5	3	3	11
PM	100	47	11	7	5	1	14	6	1	2	1	2	8	8	10
SE	84	73	17	9	18	5	2	12	1	2	3	2	4	2	9
NF	94	67	42	5	16	3	4	18	2	2	3	3	2	1	9
TM	94	57	16	4	12	1	4	12	2	5	3	4	0	0	9
MS	72	127	20	4	11	9	6	1	5	9	3	5	1	0	8
CN	85	79	17	5	13	3	5	12	3	3	3	4	0	0	8
LS	97	52	19	6	11	3	9	34	2	3	1	3	0	1	7
FF	91	51	17	8	11	4	6	17	3	1	1	2	1	1	12
RC	79	67	10	8	21	4	2	16	3	2	0	1	2	1	12
PT	77	110	20	11	14	3	5	6	4	4	1	3	0	0	9
PR	97	64	16	8	27	7	5	3	3	2	0	0	4	2	9
IM	66	122	15	8	14	5	5	5	3	5	0	3	2	2	4
ES	78	118	17	9	20	4	5	10	3	3	1	3	1	0	7
AS	88	41	12	10	14	6	3	27	4	2	4	0	3	1	12

Source: Primary Data, 2021

Table A. 8:Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Gender	95.72	808.027	-.072	.941
Marital status	97.38	805.958	.003	.941
Educational level	95.26	801.661	.114	.941
Specialisation	95.09	822.466	-.259	.944
SNSs member	97.09	808.233	-.129	.941
SNSs accessibility	97.95	808.618	-.070	.941
Frequency of Use	95.44	794.653	.138	.942
SNSs	97.18	803.834	.074	.941
eLearning model	97.42	803.410	.108	.941
eLearning	97.14	804.588	.086	.941

Source: Primary Data, 2021

Table A. 9:Correlation of variables

Correlations					
Spearman's rho		**Age**	**Gender**	**Area of study**	**SNSs Member**
Age	Correlation Coefficient	1.000	.120	.087	.092
	Sig. (2-tailed)	.	.079	.200	.175
	N	218	217	218	218
Gender	Correlation Coefficient	.120	1.000	.104	-.031
	Sig. (2-tailed)	.079	.	.128	.645
	N	217	217	217	217
Area of study	Correlation Coefficient	.087	.104	1.000	.060
	Sig. (2-tailed)	.200	.128	.	.375
	N	218	217	218	218
SNSs Member	Correlation Coefficient	**.092**	**-.031**	**.060**	1.000
	Sig. (2-tailed)	.175	.645	.375	.
	N	218	217	218	218

Source: Primary Data, 2021

Table A. 10: Total variance explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	12.518	54.426	54.426	12.518	54.426	54.426	5.687	24.725	24.725
2	1.833	7.970	62.396	1.833	7.970	62.396	5.463	23.750	48.475
3	1.018	4.428	67.824	1.018	4.428	67.824	4.220	18.349	67.824
4	.866	3.767	70.590						
5	.770	3.349	73.940						
6	.661	2.876	77.815						
7	.609	2.649	79.464						
8	.562	2.442	81.906						
9	.479	2.084	83.991						
10	.440	1.911	85.902						
11	.384	1.668	87.569						
12	.365	1.586	89.156						
13	.346	1.505	90.660						
14	.333	1.446	92.106						
15	.306	1.330	93.437						
16	.269	1.168	94.604						
17	.250	1.085	95.690						
18	.210	.912	97.602						
19	.195	.850	97.452						
20	.183	.795	98.247						
21	.161	.699	98.946						
22	.142	.617	99.563						
23	.101	.437	100.000						

Extraction Method: Principal Component Analysis.

Source: Primary Data, 2021

Table A. 11:Rotated Component Matrix

Rotated Component Matrix[a]				
		Component		
		1	2	3
EUL	Ease of use	.758		
MSL	Messaging	.736		
LSL	Live Streams	.717		
IML	Instant messaging facility	.717		
ASL	Advanced Search	.709		
RCL	Recommendations	.673		
CSL	Classmates, friends and co-worker search engine	.629		
PTL	Participation	.617		
NFL	News feed	.509		
KNL	Knowledge exchange		.812	
DIL	Disseminating of information		.809	
REL	Research		.788	
CH	Channels for communication		.783	
EIL	Encouraged interactivity in both peer and academic support		.717	
PNL	Establishment of professional networking and making new contacts		.640	
NTL	Novel tools for teaching, learning, and enhancing educational interactions among peers, students, instructors, and preceptors		.584	
SAL	Stay abreast of news and information pertaining to their professional interests by following or subscribing to updates in SNSs		.547	
PML	Photo album management			.779
FFL	Flagging features			.694
TML	Timeline			.616
PRL	Profile management			.600
CNL	Customized Notifications			.587
ECL	Enhanced the construction of students' own learning and the continuation of their engagement in development			.570

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 6 iterations.

\+ Source: Primary Data, 2021

Table A. 12:Characteristics/features/uses of SNSs

	Facebook	WhatsApp	Twitter	MySpace	LinkedIn	Sasai	Instagram	YouTube	WeChat	Messenger	TikTok	Telegram	Pinterest	SnapChat	None of the above
CH	45	38	9	0	6	0	0	0	0	0	0	0	0	0	0
DI	44	35	8	0	4	0	0	0	0	0	0	0	0	0	0
RE	41	29	3	0	6	0	0	2	0	0	0	0	0	0	0
KE	44	34	6	1	4	0	0	0	0	0	0	0	0	0	0
PN	42	26	4	0	9	0	0	0	0	0	0	0	0	0	0
EI	43	26	3	0	8	0	0	1	0	0	0	0	0	0	0
NT	42	26	3	0	7	0	1	5	0	0	0	0	1	0	0
SA	41	29	8	0	6	0	1	1	0	0	0	0	0	0	0
EC	42	26	5	0	4	1	0	1	0	0	0	0	0	0	0
PM	44	23	2	2	4	1	0	0	0	0	0	0	0	0	0
SE	43	27	3	2	9	1	0	1	0	0	0	0	0	0	0
NF	44	22	9	1	9	0	0	2	0	0	0	0	0	0	0
TM	45	21	4	1	10	1	0	2	0	1	0	0	0	0	0
MS	44	39	13	2	6	1	1	0	0	0	0	0	0	0	0
CN	43	27	5	1	13	1	1	4	0	0	0	0	0	0	0
LS	44	20	5	0	6	1	0	10	0	0	0	0	0	0	0
FF	41	18	6	0	12	2	1	10	0	0	0	0	0	0	0
RC	41	21	4	0	10	2	1	6	0	0	0	0	0	0	0
PT	42	31	10	1	4	1	1	1	0	0	0	0	0	0	0
PR	43	22	7	1	4	1	0	1	0	0	0	0	0	0	0
IM	44	38	14	2	2	3	1	0	0	1	0	0	0	0	0
ES	45	33	12	1	1	2	0	1	0	1	0	0	0	0	0
AS	44	18	3	1	12	1	2	4	0	1	0	0	0	0	0

Source: Primary Data, 2021

Table A. 13: Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Age	69.10	210.650	-.260	.864
Gender	69.57	204.850	-.040	.858
Marital status	69.12	205.666	-.090	.858
Educational level	69.65	203.513	.037	.857
Specialisation	67.22	200.053	.134	.857
SNSs member	68.84	204.335	-.001	.857
SNSs accessibility	69.69	214.780	-.321	.870
Frequency of use	67.53	205.654	-.075	.861
SNSs communication	68.71	205.852	-.109	.858
eLearning model	69.35	202.233	.188	.855
eLearning compulsory	68.88	204.546	-.027	.859

Source: Primary Data, 2021

Table A. 14:Correlation of variables

	Spearman's rho	Age	Gender	Area of study	SNSs Member
Age	Correlation Coefficient	1.000	-.255	.154	-.061
	Sig. (2-tailed)	.	.069	.277	.666
	N	52	52	52	52
Gender	Correlation Coefficient	-.255	1.000	-.255	-.312*
	Sig. (2-tailed)	.069	.	.068	.024
	N	52	52	52	52
Area of study	Correlation Coefficient	.154	-.255	1.000	.162
	Sig. (2-tailed)	.277	.068	.	.253
	N	52	52	52	52
SNSs Member	Correlation Coefficient	**-.061**	**-.312***	**.162**	1.000
	Sig. (2-tailed)	.666	.024	.253	.
	N	52	52	52	52
*. Correlation is significant at the 0.05 level (2-tailed).					

Source: Primary Data, 2021

Table A. 15: SNS usage

Variable (frequency of use)	Students	Lecturers	Administrators
Yes	62.0	67.0	67.3
Maybe	7.6	7.9	30.8
No	31.3	27.1	1.9
Variable (frequency of use)			
Daily	81.6	87.6	84.6
Every two weeks	.5	1.2	-
Monthly	1.8	1.9	1.9
Once in a while	7.9	1.9	9.6
Weekly	9.2	7.5	1.9

Source: Primary Data, 2021

Table A. 16: Mean of the SNSs to be included

	Students	**Lecturers**	**Administrators**	**Overall mean**
Mean	4.6614	5.2569	9.4423	7.45
Median	3.0000	4.0000	15.0000	
Mode	1.00	3.00	15.00	
Std. Deviation	4.32371	4.27489	7.28541	
Range	14.00	14.00	14.00	
Minimum	1.00	1.00	1.00	
Maximum	15.00	15.00	15.00	

Source: Primary Data, 2021

Table A. 17: Mean of services to be included

	Students	Lecturers	Administrators	Overall mean
Mean	10.7310	9.8211	13.7308	11.427
Median	15.0000	10.0000	15.0000	
Mode	15.00	15.00	15.00	
Std. Deviation	5.68321	4.58611	3.56517	
Range	14.00	14.00	12.00	
Minimum	1.00	1.00	3.00	
Maximum	15.00	15.00	15.00	

Source: Primary Data, 2021

Table A. 18: Features, uses and characteristics

Rotated Component Matrix[a]			
Items		**Student**	**Lecturer**
Component 1			
RC	Recommendations	.731	.673
AS	Advanced Search	.718	.709
MS	Messaging	.711	.736
EC	Enhanced the construction of students' own learning and the continuation	.698	
IM	Instant messaging facility	.690	.717
SA	Stay abreast of news and information pertaining to their professional	.686	.428
EU	Ease of use	.685	.758
PT	Participation	.670	.617
LS	Live Streams	.666	.717
PR	Profile management	.652	.437
NF	News feed	.640	.509
CN	Customized Notifications	.595	.418
CS	Classmates, friends and co-worker search engine	.585	.629
Component 2			
NT	Novel tools for teaching, learning, and enhancing educational	.443	.584
KN	Knowledge exchange	.798	.812
RE	Research	.793	.788
DI	Disseminating of information	.782	.809
CH	Channels for communication	.751	.783
PN	Establishment of professional networking and making new contacts	.578	.640
EI	Encouraged interactivity in both peer and academic support	.552	.717
Component 3			
PM	Photo album management	.816	.779
FF	Flagging features	.723	.694
TM	Timeline	.628	.616

Source: Primary Data, 2021

APPENDIX 5:Expert questionnaire

UNISA university of south africa

PARTICIPANT INFORMATION SHEET

Ethics clearance reference number: 2020/CSET/SOC/018

Research permission reference number:

29 August 2022

Title: Federated Social Networking Sites as a tool for E-Learning in Zimbabwean Universities

Dear Prospective Participant

My name is Beauty Mugoniwa and I am doing research with Prof. E.N. Ketcha, a professor in School of Computing towards a PhD in Information Systems at the University of South Africa. We are inviting you to participate in a study entitled" Federated Social Networking Sites as a tool for E-Learning in Zimbabwean Universities".

This study is expected to collect important information that could help to develop a SNSs federated framework which can be used as an e-learning tool by Zimbabwean Universities in the endeavour to reduce time spend by students on non-academic activities on the SNSs sites.

We have chosen you to participate in our study because you are the ones who have vast knowledge and experience in eLearning and social networking sites activities. We are looking forward to have about 10 reviewers who will participate in the study.The study involves the proposed framework which the participant needs to review and give recommendation which will be used to validate the framework, the participants are required to have completed the review in two weeks' time, to enable the researchers to have enough time to collect them and prepare them for data analysis.

Participating in this study is voluntary and you are under no obligation to consent to participation. If you do decide to take part, you will be given this information sheet to keep and be asked to sign a written consent form. You are free to withdraw at any time before you have submitted your questionnaire and without giving a reason but if you have already submitted, you will not be able to withdraw it.

The nature of our research does not anticipate any risks, because we are sending questionnaires online, no human interaction is required and no personal information is required.
You have the right to insist that your name will not be recorded anywhere and that no one, apart from the researcher and identified members of the research team, will know about your involvement in this research and your name will not be recorded anywhere and no one will be able to connect you to the answers you give. Your answers will be given a code number or a pseudonym and you will be referred to in this way in the data and in the thesis report. Your answers may be reviewed by people responsible for making sure that research is done properly, including members of the Research Ethics Review Committee. Otherwise, records that identify you will be available only to people working on the study, unless you give permission for other people to see the records. Part of the study data maybe produced in other publication, other than thesis report, but individual participation will not be identifiable in the report.
Information from data collection will be stored on a password protected computer. Future use of the stored data will be subject to further Research Ethics Review and approval if applicable. After 5 years of storing the data files from collected data will be overwritten to clear them using the right and effective software which will be available at that time, that is 5 years from now.
No incentives are expected to be given for participants to participate in the study or after the study. No extra costs are expected to be incurred by the participants because they will be using already subscribed internet access to access the questionnaires and send them back.
If you would like to be informed of the final research findings, please contact Beauty Mugoniwa on 00263774016630 or mugoniwabm@gmail.com. Should you require any further information or want to contact the researcher about any aspect of this study, please contact Beauty Mugoniwa on 00263774016630 or mugoniwabm@gmail.com.

Should you have concerns about the way in which the research has been conducted, you may contact Prof. E.N. Ketcha on +27-(0)12-4296865, fax: +27-(0)12-4296848 or ngassek@unisa.ac.za. Contact the research ethics chairperson of the socethics@unisa.ac.za if you have any ethical concerns.

Thank you for taking time to read this information sheet and for participating in this study.
Thank you.

B. Mugoniwa

Beauty Mugoniwa

FRAMEWORK VALIDATION TEMPLATE

Title: Federation of Social Networking Sites as a tool for eLearning in Universities: a case of Midlands State University in Zimbabwe

Dear expert reviewer

Thank you for taking part as an expert to validate the framework: Federated Social Networking Sites. I would greatly appreciate your participation in this study. I am Beauty Mugoniwa, am doing research with Prof. E.N. Ketcha, a professor in the School of Computing towards a PhD at the University of South Africa. I am carrying out a research on "Federated Social Networking Sites as a tool for eLearning in Universities, a case for Midlands State University in Zimbabwe".

The aim of the study is to develop a federated SNSs framework which can be used as an eLearning tool by Zimbabwean Universities in the endeavour to reduce time spend by students on non-academic activities on the SNSs sites. I have chosen you to guide me with your vast knowledge and experience in Social networking sites and/or tertiary institutions to review my framework and give me ideas on whether and how to improve it or to use it in the learning institutions. The potential benefits of this study are that the output from the research will give students and their facilitators flexible and sociable environment for teaching and learning. Potential risks of the COVID-19 spread are curbed by the use of online forms instead of hardcopy as was initially proposed, no other risks are anticipated during the study. The research will abide by all the ethical considerations (academic ethics, professional ethics and participants).

Feedback procedure will entail the dissemination of my research findings in the form of the finished thesis, journal papers and conference papers.

For further clarity about the research please feel free to conduct the undersigned or the thesis supervisor on eketcha@gmail.com.

This template is divided into 3 sections: Section A is for demographic information; Section B is designed to provide definitions of what are deemed as quality requirements of the framework. The purpose is to ensure that expert reviewers have a shared understanding about the quality requirements of the framework and Section C presents the qualitative needs of the framework.

Demographic Information Section

1. Gender

2. Organisation

3. Highest qualification

4. Designation and/ or position

5. Duties and responsibilities

6. Years of experience in Tertiary Instituitions

Definitions of parameters

Below is a table with the parameters which may guide you in validating the framework

No.	Parameter	Definition	references
1.	Relevance	Does the framework address the needs/ objectives of the research/ study	(Hevner et al., 2004)
2.	Usefulness	The net benefits the users benefit from the framework	(Hevner et al., 2004)
3.	Logical flow /simplicity	Is the framework practical and the stages involved simple enough to be readily understood by the users	(Calder & Tybout, 2016)
4.	Completeness	Does the framework have all the necessary components that are needed for it to work properly	(Hevner et al., 2004)
5.	Usability	The framework should be designed in such a way that users can use it without problems	(Hevner et al., 2004)
6.	Rigor and exactness	The appropriateness of the method to answer the questions/ the quality or state of being very exact, careful, or with strict precision or the quality of being thorough and accurate.	(Cypress, 2017; Gill & Gill, 2020)
7.	Parsimony	Achieves good levels of predictive and explanatory power in relation to its focal phenomena using a small number of constructs, associations and boundary conditions (simplicity) / Is the framework practical and the stages involved simple enough to be readily understood by the users.	(Rajendran, 2015; Lincoln & Lynham, 2011)

7. Relevance *

8. Logical flow *

9. Completeness *

10. Usefulness *

11. Usability *

12. Rigor and exactness *

13. Parsimony *

14. Anything that you may want to add, justify: *

15. Anything that you may want to be removed, justify : *

END OF FRAMEWORK VALIDATION

APPENDIX 6: Framework validation guide

Introduction

My name is Beauty Mugoniwa, I am doing research with Prof. E.N. Ketcha, a professor in the School of Computing towards a PhD at the University of South Africa. I am carrying out a research on "Federation of Social Networking Sites as a tool for eLearning: a case Midlands State University in Zimbabwe."

The aim of the study is to develop a federated SNSs framework which can be used as an eLearning tool by Zimbabwean Universities in the endeavour to reduce time spend by students on non-academic activities on the SNSs sites.

I have chosen you to guide me with your vast knowledge and experience in Social networking sites and/or tertiary institutions to review my framework and give me ideas on whether and how to improve it or to use it in the learning institutions.

I have sent a separate email with google forms that you are requested to fill as a way of validating the framework. The main requirements of the google form are for to provide your demographic information and validate the framework using the provided qualitative needs of the framework, which are also explained in the table below.

Below is a table with the parameters which may guide you in validating the framework

No.	Parameter	Definition	references	
1.	Relevance	Does the framework address the needs/ objectives of the research/ study	(Hevner *et al.*, 2004b)	Yes. The framework cover essential SNS platforms
2.	Usefulness	The net benefits the users benefit from the framework	(Hevner *et al.*, 2004b)	Currently these platforms though commonly used and affordable they transfer non academic content. The framework would validate content and make research easier for the student
3.	Logical flow /simplicity	Is the framework practical and the stages involved simple enough to be readily understood by the users	(Calder and Tybout, 2016)	The flow is clear for users as it conforms to usual communication flow patterns
4.	Completeness	Does the framework have all the necessary components that are needed for it to work properly	(Hevner *et al.*, 2004b)	At the technical level details on protocols, media access methods and security maybe needed to validate usability in mobile low data rate environments
5.	Usability	The framework should be designed in such a way that users can use it without problems	(Hevner *et al.*, 2004b)	It is possible to use the framework as a user without any challenges the flow uses familiar methods
6.	Rigor and exactness	The appropriateness of the method to answer the questions/ the quality or state of being very exact, careful, or with strict precision or the	(Cypress, 2017; Gill & Gill, 2020)	The model can achieve this requirement because of the role of central management through FSN coordinator and also the administrator role

		quality of being thorough and accurate.		
7.	Parsimony	Achieves good levels of predictive and explanatory power in relation to its focal phenomena using a small number of constructs, associations and boundary conditions (simplicity) / Is the framework practical and the stages involved simple enough to be readily understood by the users.	(Rajendran, 2015; Lincoln & Lynham, 2011)	The framework is very practical and relevant for the Zimbabwean environment or African environment where access to non-predatory sources for research remains a challenge. And also it is the most used platform but for non-academic purposes. Harness its wide user base and easy of use it can improve learning. Peer-Peer links provides good collaboration for student-student and lecturer to student knowledge sharing platform

Research question of the study

How can a Framework of Federated Social Network Sites for eLearning be developed for the purpose of improving learning through SNSs at universities? In order for the study to address this question, the following specific research questions need to be addressed.

Sub-Research Questions (SRQ)

Sub-Research Question 1(SRQ1): *What are the SNSs in existence and are their characterisation?* This stage requires SNSs to be defined, their characteristics explained, the functions of the SNSs in eLearning related or academic activities to be discussed in order to answer the research question.

Sub-Research Question 2 (SRQ2): *What are the eLearning frameworks that are in existence in the literature?* This entails the study of the background of eLearning Frameworks, defining basic concepts associated with eLearning , the benefits of the eLearning modes, different types of eLearning frameworks and the building blocks to be deduced.

Sub-Research Question 3 (SRQ3): *How to use technologies such as models, use cases, flowcharts and architectures to develop a framework with the guidance of the existing eLearning frameworks and framework development theories?* The model to the conceptual framework, the

use cases, the flow chart and the system states of the theory which aid the framework development will be presented.

Sub-Research Question 4 (SRQ4): *How can federated SNSs be validated, improved to get an improved version that can be used as an eLearning tool in Universities?* the validation of the framework by students and framework will certify whether the framework is suitable and applicable to the education system at hand.

Acronyms

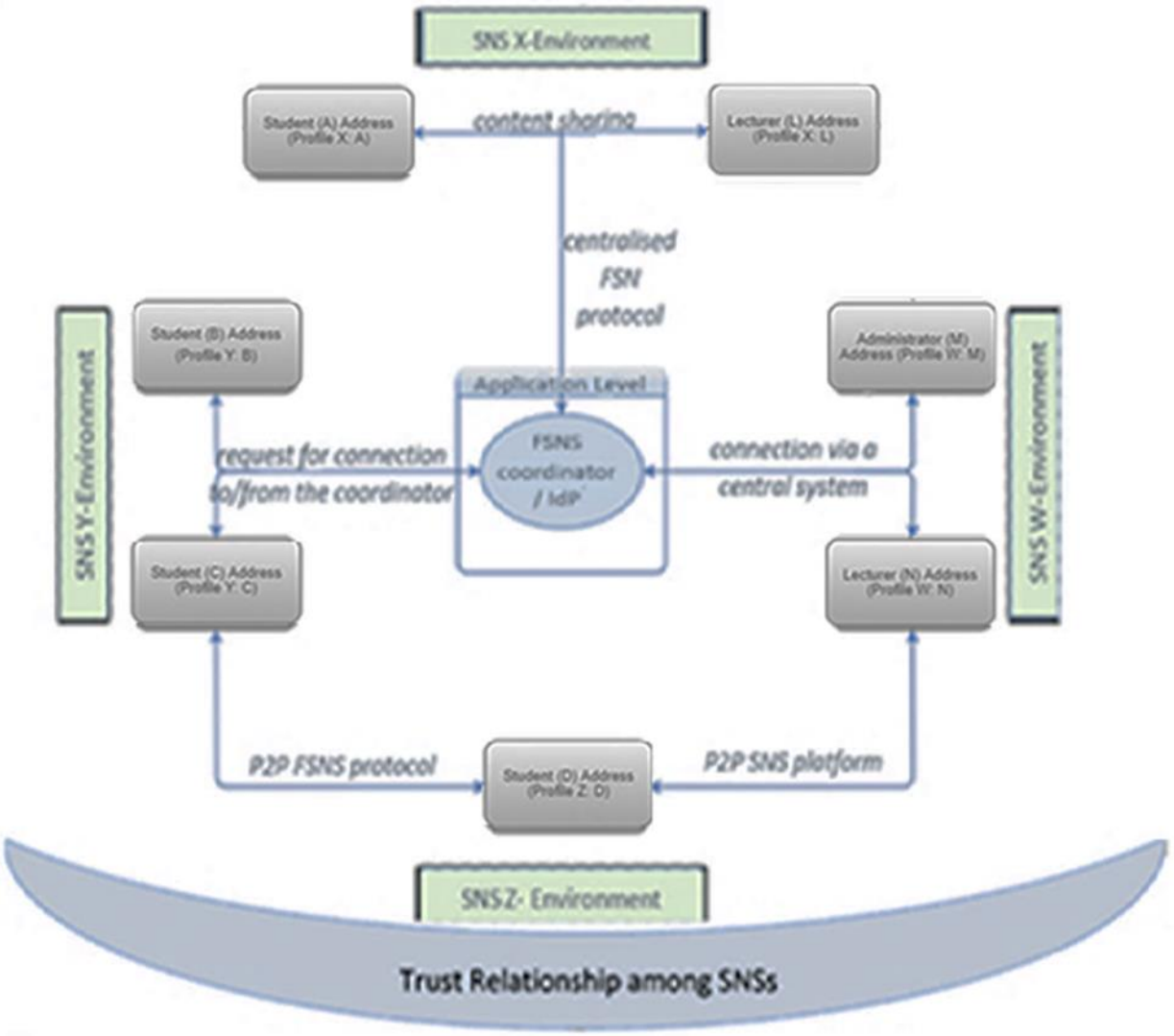
SNS/s- social networking site/s

FSNS/s- Federated social networking site/s

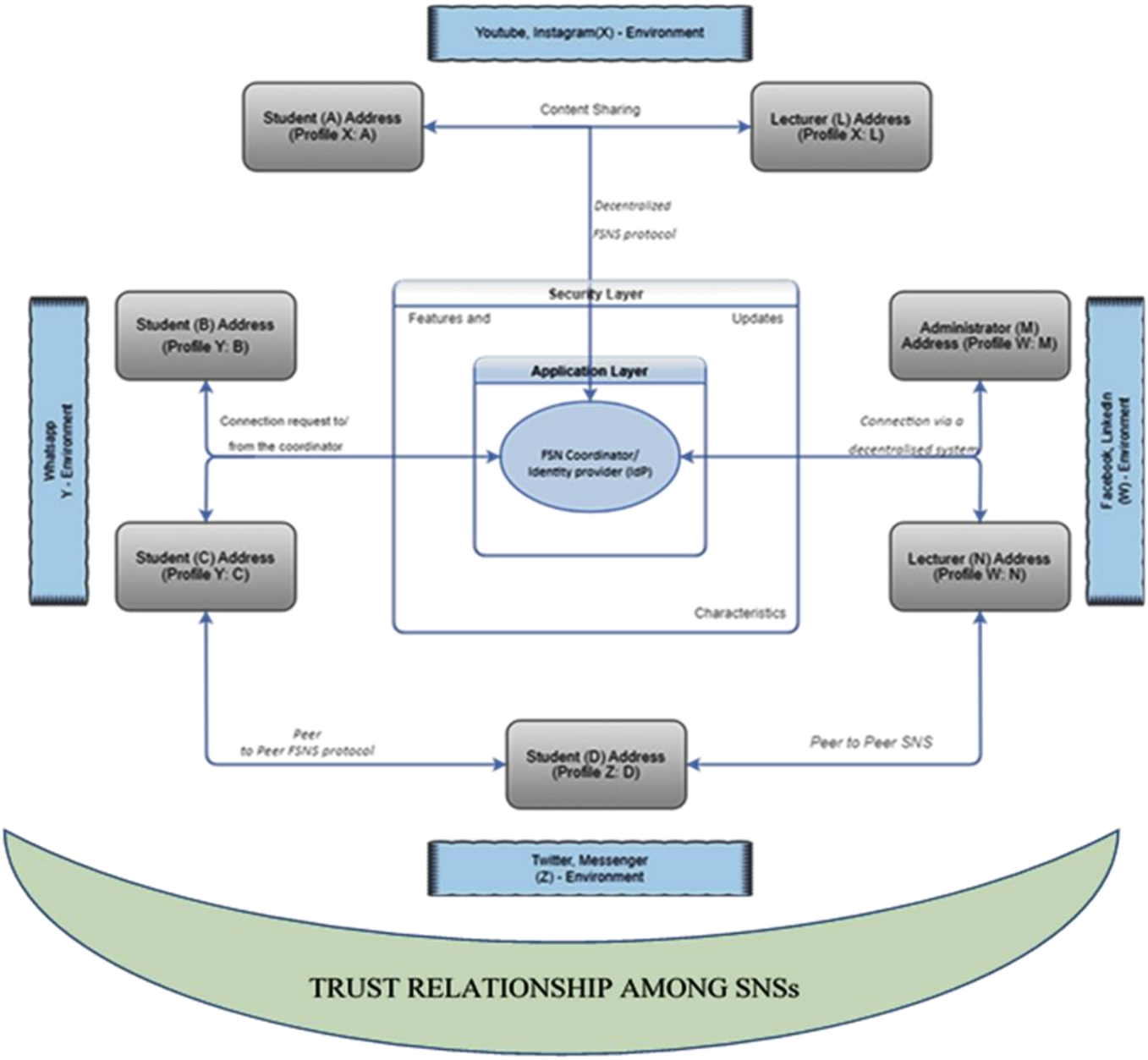
FE -front end

BE-back end

Framework Before data collection(quantitative)



Framework After data collection



Explanation of the Framework

In this framework, some requests and transmissions goes through a coordination model that handle any routing from one SNS to another and even within. The FSNS coordinator has the ability to plug into any SNS and vice versa and can easily register a user in any other SNS for transmitting messages when necessary. On the other side each SNS maintains its own integrity but it has the ability to pass messages to other SNS. The framework is a combination of Peer to Peer and Client

to Server framework, when the communication involves fewer users, the peer to peer takes over, om the other side communication among many users with different SNSs the client to server is used. Like in the client to server framework an administrator (M) registered to social networking site SNSs W can communicate to a student (A) and (B) through the FSNS coordinator. The request is directed to the FSNS coordinator which handles all the orchestration. In the Coordinator, despatcher in the FSNS interprets the request from M, realizes that A is registered on SNSs X and B is registered on SNSs Y, then asks the BE Orchestrator to transparently invoke SNSs X and SNSs Y and direct all requests to SNSs X and Y, and receives feedback from X and Y, then forward it to SNSs W thereby facilitating and controlling communication of client M with A and B using the appropriate protocols. The FE orchestrator will be responsible for enrooting the messages/commands/information/data to the destination federated social network application for users M, A and B. However, student C and student D can have a communication connection using the principle in peer to peer framework without the use of the central coordination control. The main modules of the diagram are explained below:

SNSs Environment

Refers to social networking application environment provided by a specific social networking sites, within which users are registered to communicate or connect to each other and share content of special interest

Address profile

It is the user identity which is social networking site after being registered to that specific site. Thus it enables one to enjoy the facilities of a specific SNSs such as content sharing amongst SNSs users. Every registered user has his/ her unique profile

Peer to peer SNSs protocol

This is a standard of communication which is dedicated between two or more social networking sites which enforces independent communication and procedures without a central controlling/ coordinating system. The terms and conditions are independently agreed upon and established between interested social networking sites.

The application layer

It is the federated social networking layer which provides an interface for interaction between the users and the system through Features and uses, Characteristics and Updates such as video call, chats, instant messaging, content sharing, Knowledge exchange and Channels for communication

Centralized FSNSs protocol

Is a communication standard established among various social networking sites platform, but through a centralized system which involves a FSNSs coordinator and FSNSs identity provider. Every federated social networking request is done via a central server

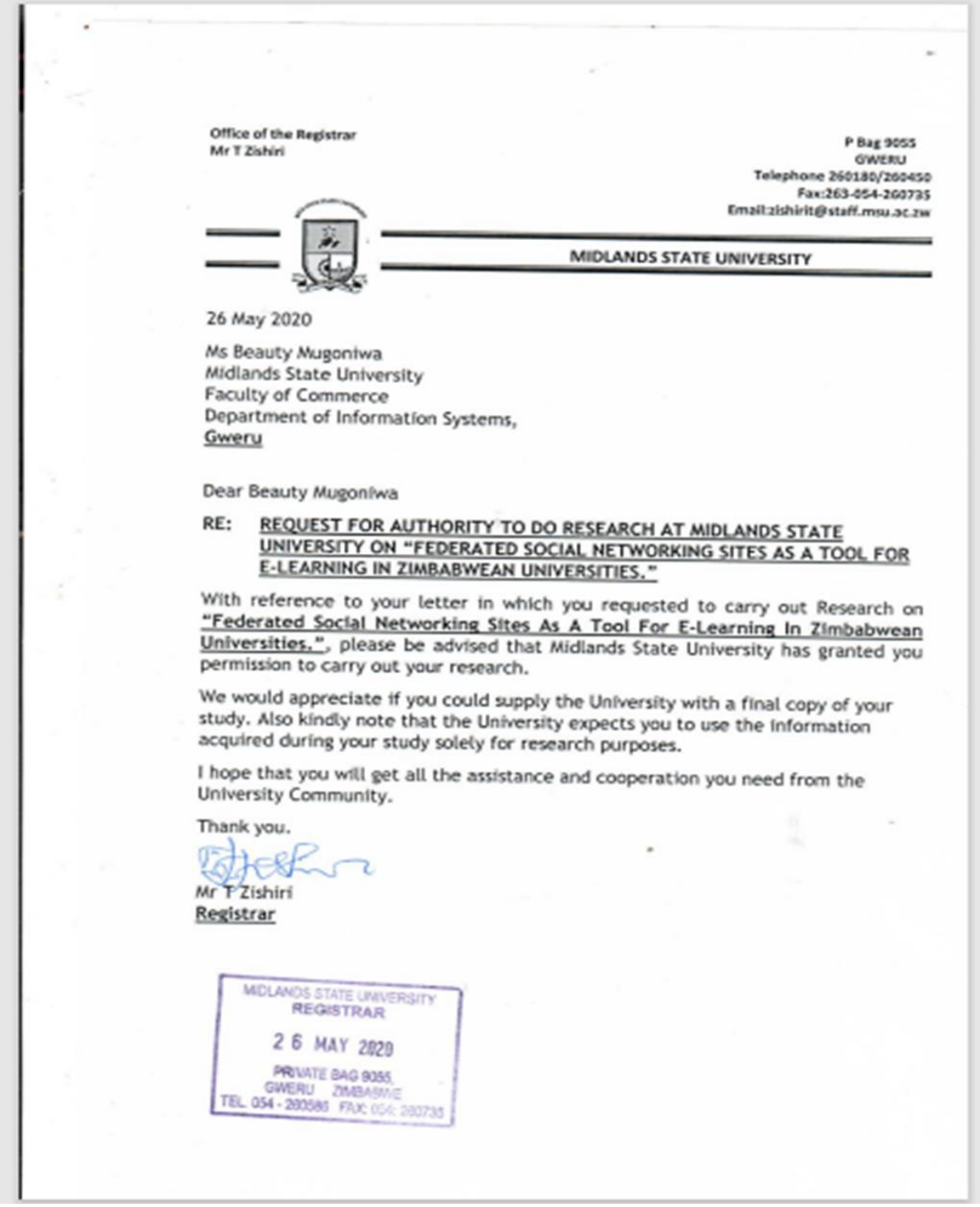
FSNSs coordinator

Responsible for routing messages, commands, data or request to and from various Federated Social Network Service. It is the heart the centralized.

Trust relationship

Created through strong business values and ethics which binds FSNSs sites in provision of the much needed service.

APPENDIX 7: Research Permission



Office of the Registrar
Mr T Zishiri

P Bag 9055
GWERU
Telephone 260180/260450
Fax:263-054-260735
Email:zishirit@staff.msu.ac.zw

MIDLANDS STATE UNIVERSITY

26 May 2020

Ms Beauty Mugoniwa
Midlands State University
Faculty of Commerce
Department of Information Systems,
Gweru

Dear Beauty Mugoniwa

RE: REQUEST FOR AUTHORITY TO DO RESEARCH AT MIDLANDS STATE UNIVERSITY ON "FEDERATED SOCIAL NETWORKING SITES AS A TOOL FOR E-LEARNING IN ZIMBABWEAN UNIVERSITIES."

With reference to your letter in which you requested to carry out Research on "Federated Social Networking Sites As A Tool For E-Learning In Zimbabwean Universities," please be advised that Midlands State University has granted you permission to carry out your research.

We would appreciate if you could supply the University with a final copy of your study. Also kindly note that the University expects you to use the information acquired during your study solely for research purposes.

I hope that you will get all the assistance and cooperation you need from the University Community.

Thank you.

Mr T Zishiri
Registrar

MIDLANDS STATE UNIVERSITY
REGISTRAR
26 MAY 2020
PRIVATE BAG 9055
GWERU ZIMBABWE
TEL 054 - 260560 FAX 054 260735

APPENDIX 8: Ethical clearance certificate

UNISA university of south africa

UNISA COLLEGE OF SCIENCE, ENGINEERING AND TECHNOLOGY'S (CSET) ETHICS REVIEW COMMITTEE

2021/05/14

Dear Ms Beauty Mugoniwa

ERC Reference #: 2020/CSET/SOC/018
Name: Beauty Mugoniwa
Student #: 50879030
Staff #:

Decision: Ethics Approval from 2021/05/14 for five years Humans involved.

Researcher(s): Beauty Mugoniwa
50879030@mylife.unisa.ac.za, +263774016630

Supervisor (s): Prof. Ernest Ngassam Ketcha
eketcha@gmail.com, +27823552519

Working title of research:

Federated Social Networking Sites as a tool for E-Learning in Zimbabwean Universities

Qualification: PhD in Information Systems

Thank you for the application for research ethics clearance by the Unisa College of Science, Engineering and Technology's (CSET) Ethics Review Committee for the above mentioned research. Ethics approval is granted for 5 years.

*The **low risk application** was expedited by the College of Science, Engineering and Technology's (CSET) Ethics Review Committee on 2021/05/14 in compliance with the Unisa Policy on Research Ethics and the Standard Operating Procedure on Research Ethics Risk Assessment. The decision will be tabled at the next Committee meeting for ratification.*

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsimile: +27 12 429 4150
www.unisa.ac.za

The proposed research may now commence with the provisions that:

1. The researcher will ensure that the research project adheres to the relevant guidelines set out in the Unisa COVID-19 position statement on research ethics attached.
2. The researcher(s) will ensure that the research project adheres to the values and principles expressed in the UNISA Policy on Research Ethics.
3. Any adverse circumstance arising in the undertaking of the research project that is relevant to the ethicality of the study should be communicated in writing to the College of Science, Engineering and Technology's (CSET) Ethics Review Committee.
4. The researcher(s) will conduct the study according to the methods and procedures set out in the approved application.
5. Any changes that can affect the study-related risks for the research participants, particularly in terms of assurances made with regards to the protection of participants' privacy and the confidentiality of the data, should be reported to the Committee in writing, accompanied by a progress report.
6. The researcher will ensure that the research project adheres to any applicable national legislation, professional codes of conduct, institutional guidelines and scientific standards relevant to the specific field of study. Adherence to the following South African legislation is important, if applicable: Protection of Personal Information Act, no 4 of 2013; Children's act no 38 of 2005 and the National Health Act, no 61 of 2003.
7. Only de-identified research data may be used for secondary research purposes in future on condition that the research objectives are similar to those of the original research. Secondary use of identifiable human research data require additional ethics clearance.
8. No field work activities may continue after the expiry date *expiry date*. Submission of a completed research ethics progress report will constitute an application for renewal of Ethics Research Committee approval.
9. *Permission to conduct research involving UNISA employees, students and data should be obtained from the Research Permissions Subcommittee (RPSC) prior to commencing field work.*
10. *Permission to conduct this research should be obtained from the [company, CE organisation, DoE, etc name] prior to commencing field work.*

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Note

The reference number 2021/CSET/SOC/018 should be clearly indicated on all forms of communication with the intended research participants, as well as with the Committee.

Yours sincerely,

Dr D Bisschoff

Chair of School of Computing Ethics Review Subcommittee

College of Science, Engineering and Technology (CSET)

E-mail: dbischof@unisa.ac.za

Tel: (011) 471-2109

Prof. E Mnkandla

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Prof. B Mamba

Executive Dean

College of Science Engineering and Technology (CSET)

E-mail: mambabb@unisa.ac.za

Tel: (011) 670 9230

APPENDIX 9: Editor's Certificate

Certificate of Editing

PhD Thesis

FEDERATED SOCIAL NETWORKING SITES AS A TOOL FOR eLEARNING: A CASE OF MIDLANDS STATE UNIVERSITY IN ZIMBABWE

by

BEAUTY MUGONIWA

Edited for English language usage:

- Proofreading for mechanical errors such as spelling, punctuation, grammar.
- Copy-editing that includes commenting on, but not correcting, structure, organisation and logical flow of content, basic formatting (headings, page numbers), eliminating unnecessary repetition.
- Checking citation style is correct, punctuating as needed and flagging missing or incorrect references.
- Commenting on suspected plagiarism and missing sources.
- Returning the document with track changes for the author to accept.

I confirm that I have met the above standards of editing and professional ethical practice. The content of the work edited remains that of the student.

Lorinda Gerber
21st of August 2023

Note: I am not accountable for any changes made to this document subsequent to my edit.

Copy-Editing

Professional EDITORS Guild

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APPENDIX 10: Turnitin Similarity Index report

Turnitin Originality Report

Processed on: 17-Sep-2023 01:07 SAST
ID: 2167925888
Word Count: 76920
Submitted: 1

first draft 1 By Beauty MUGONIWA

Similarity Index	Similarity by Source	
10%	Internet Sources:	8%
	Publications:	4%
	Student Papers:	5%

1% match (student papers from 28-Apr-2015)
Submitted to Midlands State University on 2015-04-28

1% match (Internet from 04-Nov-2022)
http://ir.msu.ac.zw:8080/jspui/bitstream/11408/4484/1/Mahlangu_Gilbert_218327943.pdf

1% match (Internet from 29-Oct-2012)
http://www.netreference.co.kr/bbs/view.php?id=cshare&no=299

< 1% match (student papers from 15-Aug-2021)
Submitted to Midlands State University on 2021-08-15

< 1% match (student papers from 28-Jul-2021)
Submitted to Midlands State University on 2021-07-28

< 1% match (student papers from 06-Dec-2022)
Submitted to Midlands State University on 2022-12-06

< 1% match (student papers from 17-Jun-2016)
Submitted to Midlands State University on 2016-06-17

< 1% match ()
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