A SOCIOTECHNICAL APPROACH TO UNDERSTAND AN ONLINE APPLICATION SYSTEM DEVELOPMENT: A UNIVERSITY CASE STUDY

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Declaration

I have read and understood the Senate Policy on Plagiarism

I understand that plagiarism is the "failure to acknowledge the ideas or writing of another" or "presentation of the ideas or writing of another as one's own" - whether such failure to acknowledge the ideas or writings of others is intentional or unintentional.

I therefore, declare that this research project is my own work, except as acknowledged in the text. It has not been submitted before for any other degree or examination in this or any other university.

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Abstract

In a rapidly changing world of technological advancement and innovation, academic institutions are propelled to automate manual processes for more efficiency and access to a broader spectrum of applicants. For this reason, universities are investing in online application system to deal with long queues, malpractice, loss of documents, and undue costs incurred by the university. However, online application systems that do not adequately address sociotechnical requirements may result in an unsuccessful implementation, wasteful expenditure and sometimes reputational damage to the university. This research suggests a general sociotechnical conceptual framework which was informed by both the traditional System Development Life Cycle (SDLC) and Effective Technical & Human Implementation of Computer-based Systems (ETHICS) methodology to understand the development of an online application system using a sociotechnical approach. An exploratory research approach was used on an online application system case study to understand what sociotechnical aspects were considered during the application development and the outcome thereof. Qualitative data sources were examined to understand the context and rationale for any sociotechnical issues incorporated or excluded in the online application system development. Based on new discoveries, the sociotechnical conceptual framework was enhanced to be more relevant for academics, practitioners and organisations to use as a guide for a sociotechnical system development approach.

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1. Introduction

This chapter gives a background of the study, in particular the context that lead to the introduction of an online application system in the university and why the study is approached from a sociotechnical perspective. Thereafter, the problem statement that informs the study is presented together with the purpose of conducting the study in response to the identified problem. This is then followed by the research questions and objectives justifying the need and significance of conducting the study.

1.1. Background

Student services are the administration backbone of higher education and are often the first and last contact points of the students (Voorhis and Falkner, 2004). As such, many institutions of higher learning in the world are accustomed to automating manual application and application processes to stay abreast with increasingly advancing information technology (Agwa-Ejon and Pradhan, 2017).

According to Zalanowski (2007) online technologies such as email, websites and blogs get implemented to help enrollment management professionals reach a broader spectrum of students efficiently. Moreover, online application systems eliminate the use of paper, enable remote access, reduce manpower required from staff, provide precise information and reduce malpractice (Bharamagoudar et al., 2013; Chaka and Mungadzi, 2013)

However, in pursuit of achieving the above objective, organisations may focus their attention more on the technical aspects of system development and neglect the social issues that may hinder the success of a system (Munkvold, 2000). According to Mumford and Beekman (1994) if a technical system is created at the expense of a social system, the results obtained will be sub-optimal. As such, the frustration of users with the system may affect workplace productivity, social relationships and the overall wellbeing of users (Klein et al., 2005).

A number of researchers that studied tertiary online application systems predominantly focused on the benefits and impact of automating the manual application process (Agwa-Ejon and Pradhan, 2017; Bemile et al. 2014; Farhan, 2014; Bharamagoudar et al., 2013). Furthermore, the papers by Singh et al. (2016) and Patrick (2006) both focused on the technical complexity of developing and integrating the online application system. Whereas other researchers focus on social issues that affect the users such as usability, digital divide, user training, data confidentiality (Ngarandi, 2017; Omambia et al., 2014; Figl and Kriglstein, 2008).

Although not much literature exist for Online Application Development in Universities or institutions of higher learning, a review of other recent system development cases where studied. The paper by Kyzy, z et al (2017) looked at the 'Evaluation of Distance Education Applications in the Kyrgyz Republic Universities'. This paper found that there is no sufficient support and understanding of the distance

education by the university managements as well therefore affecting the success of the system. In addition, the paper by Yadegaridehkordi, E et al (2019) looked at the 'Decision to adopt online collaborative learning tools in higher education'. The findings show that intention to adopt is significantly affected by perceived usefulness. Furthermore, perceived usefulness and perceived ease of use are significantly influenced by collaboration. From both papers there was no coverage of both social and technical considerations in there system development.

System development is one of the areas considered to be well researched however there is limited research done focusing on both social and technical considerations for an online application system development. Hence, the purpose of this study is to understand whether the university took sociotechnical issues into consideration when developing their online application system and to analyse the implications thereof. As such, this research will use the sociotechnical theory as a lens to understand the requirements for developing an online application system using a university case study. According to Sawyer and Jarrahi (2013) the sociotechnical approach is premised on the interdependent and inextricably linked relationships among the features of any technological object or system and the social norms, rules of use and participation by a broad range of human stakeholders. Therefore, the mutual constitution of social and technology is the basis of the term sociotechnical. The sociotechnical theory is used to analyse and explore the Information System development phenomena for the university's online application system.

1.2. Problem statement

A number of institutions in developing and under developed countries are still dealing with heavy manual processes (Omambia et al., 2014). As a result, these universities find themselves having to deal with long queues, malpractice, loss of documents, and undue costs incurred by the university (Bemile et al., 2014; Chaka and Mungadzi, 2013). To overcome these challenges, most institutions of higher learning have embraced online web application systems (Tchouakeu et al., 2012). However, the success of the web application systems are not only dependent on the technical functionality but also the social applicability of the system. A number of researchers that studied tertiary online application systems predominantly focused on the benefits and impact of automating the manual application process (Agwa-Ejon and Pradhan, 2017; Bemile et al. 2014; Farhan, 2014; Bharamagoudar et al., 2013). Therefore, failure to consider and deliver on both the technical and social requirements of the system may result in an unsuccessful implementation. In addition, this may result in financial losses and failure to realise strategic IT objectives (Mumford, 2000; Sawyer and Jarrahi, 2013).

1.3. Purpose Statement

The purpose of this study is to understand whether the university took sociotechnical issues into consideration when developing their online application system and to analyse the implications thereof. The sociotechnical conceptual framework is used as a guide to study the social and technical considerations that the literature suggests are best practices for the various phases of the system development lifecycle.

1.4. Research questions:

There are two main questions identified for this research:

1. What sociotechnical issues did the university consider when developing their online application system?
2. How do sociotechnical issues during development influence the outcome of an online application system?

1.5. Research aims and objectives

Three main research objectives were identified to support the purpose of the research, which are:

1. To understand the role of sociotechnical issues in the development process of an online application system.
2. To determine the applicability of the sociotechnical conceptual framework as a guide for understanding system development from a sociotechnical perspective.
3. To identify and report any influence or implication of sociotechnical issues in the development of the online application system.

1.6. Research report structure

This paper is organized as follows:

- ***Section 2*** – This section provides a literature review of the sociotechnical theory as a lens or perspective for system development and what constitutes the sociotechnical theory.
- ***Section 3*** – This section presents a background of how the sociotechnical conceptual framework was formulated as a guide for a sociotechnical system development approach. The section also gives a graphical representation of the sociotechnical conceptual framework and narrates every subsection included for understanding.
- ***Section 4*** – Gives an account on the methodology used to conduct the research. In particular, this section presents the research paradigm, strategy and techniques used to conduct the study.
- ***Section 5*** – This section identifies sociotechnical considerations and/or issues on the various subsystems of the sociotechnical conceptual framework and gives an interpretation of their implication on the system development process.

- ***Section 6*** – The objective of this this section is to discuss the research findings together with emerging themes that warrants any amendment to the sociotechnical conceptual framework. In addition, the section gives a reflection on how the findings or emerging themes relate to existing literature.
- ***Section 7*** – This section provides the conclusion to the study and includes research contribution, limitations of the study and suggestions for future research.

The sociotechnical approach to the online application system development is derived from the sociotechnical theory. The section below gives background of where the theory emanates from together with its meaning or imperative in the body of knowledge.

2. Theoretical Background

The term "sociotechnical" was coined by researchers at the Tavistock Institute of Human Relations in England (Mumford, 2000). Their research showcased two approaches which then were at the center of the sociotechnical theory. The first, was the close association between the technological and the social (sub-) systems of organizations. The second approach was the importance of worker involvement. It is against the above understanding that the term sociotechnical implies two fundamental concepts: a social system and a technical system (Adman and Warren, 2000; Yang et al., 2012; Sadath and Gill, 2017).

Sawyer and Jarrahi, (2013) who align with the above notion define sociotechnical theory as (1) the mutual constitution of people and technologies; (2) the contextual embeddedness of this mutuality; and, (3) the importance of collective action.

Although the term sociotechnical system is loosely used to describe many complex systems, five key aspects determine a sociotechnical system (Badham et al, 2000):

- The systems have interdependent parts.
- The system adapts to and pursues goals in external environments.
- The system has an internal environment comprising of separate but interdependent technical and social subsystems.
- There is choice in the system, e.g. system goals are achievable by more than one means.
- System performance depends on jointly optimising the technical and social aspects of the system.

According to Adman and Warren (2000) the sociotechnical design process involves setting objectives and specifying alternatives separately for the social and technical components before bringing those alternatives together and ranking them. This view is reaffirmed by Mumford (2003 p. 262) who said a sociotechnical systems design replaces tight controls, bureaucracy and stress with an organization and technology that enhances human freedom, democracy and creativity. Historically, new systems and technology were developed without thorough consideration of social issues and related

implications. As such, the fundamental goal of the Tavistock researchers was to humanize jobs through redesigning work practices and workplace technologies, while propagating democracy at work (Sawyer and Jarrahi, 2013).

What people do not comprehend is that poor technical quality leads to a faulty system, but its presence does not necessarily mean success, hence the necessity for a sociotechnical approach. This is a deliberate and through consideration of various social and technical requirements being equally optimised that will determine the success of a system (Munkvold, 2000; Stahl, 2007; Sadath and Gill, 2017). It is for this reason that over the years the sociotechnical theory has been refined to talk to various technology and system implementations while addressing the both the social and technological challenges.

The above sociotechnical principles have been embraced by many organisations and researchers in particular, through defining sociotechnical models to address various industry challenges such as manufacturing, retail systems and university. Seemingly, sociotechnical systems development (STSD) grew up as a response to the overly 'technical' or 'functionalist' nature of classical information system development, which emphasised technology over people (Stapleton, 2008). Within the Information Systems fraternity, Enid Mumford who was greatly influenced by her association with the Tavistock Institute, is considered to be the most influential researcher to initiate the sociotechnical research (Davenport 2008). Bjorn-Anderson rightly called her the founder of the sociotechnical systems design school, and it's most prolific contributor (Avison et al., 2006 p. 353).

Findings from projects across the 1960 and 1970s were consolidated by Mumford, her colleagues and students where they gave rise to a system development methodology, called Effective Technical & Human Implementation of Computer-based Systems (ETHICS) (Mumford and Weir 1979). According to Sadath and Gill (2017) the main objective of the ETHICS method was to develop information systems that encourage social and technical system co-optimization. The paper further argued that the approach would contribute to a mutual beneficial relationship between the employee and the organization, job efficiency and job satisfaction. Below is a brief discussion of the two fundamental aspects of the sociotechnical theory:

2.1. Technical dimension

Technical aspects refer to the technical know-how, requirements and architecture required to make it possible for the technology or system to be developed. The best view of such a great development begins with the design. A good design and implementation of the system involves competence on the part of the engineer as well as proficiency in the domain from the expert. Examples of some technical considerations of the system include processes, tasks and technology (Adeshina and Ojo, 2014; Karsh, 2004; Sharma et al., 1991).

However, ultimately the design must be in such a way that addresses the objective of the system solution. Other researchers also argues that a system should be satisfactory to those who manage and use the system and most importantly a "good" system must lead to superior performance in terms of its architectural components-such as the knowledgebase, inference engine, explanation facility and user/developer interfaces (Klein, 2005; Adman and Warren, 2000; Goodhue, 1988).

2.2. Social dimension

Social aspects talks to the softer issues of the system development such as attitudes, culture, usefulness, performance improvements and quality of life amongst others. Furthermore social optimality is given by the support of people associated with the system (that is, the developers, management and users) and by the other macro-level organizational contexts that dictate efficiency and effectiveness (Stahl, 2007; Adeshina and Ojo, 2014; Sharma et al., 1991).

For example it has been widely recognized that social issues such as privacy and the management of personal information are crucial to the success of new technological systems and need to be addressed. If the system is perceived as non-threatening, easy to use, and enhancing the quality of work life, it would be more acceptable to users (Sadath and Gill, 2017; Adman and Warren, 2000; Mumford, 1987). Social issues are very diverse and dynamic for businesses. For example, some social considerations of a system include attributes of people (attitudes, skills, values, etc.), relationships among people, reward systems and authority structures (Munkvold, 2000)

3. Proposed sociotechnical conceptual framework

3.1. Background of the sociotechnical conceptual framework composition

According to Patnayakuni and Ruppel (2008) a system development process can be conceived as a work system whereby developers build information systems using organizational resources, which include human resources (i.e. skill and knowledge) and technological resources (i.e. development tools and the IT infrastructure). The paper by Hoffer et al (2012) indicates that in the many development techniques, the System Development Life-cycle (SDLC) model is a generally approved approach to explain the procedures and issues involved in systems development. However, the SDLC model has been criticized for not sufficiently addressing human-centered issues such as user experience, user participation and other related social aspects (Delavari et al., 2011; Zhang et al., 2002, Mahadevan et al., 2015). For this reason Zhang et al (2005) recommended a new SDLC known as Human-Centered System Development Life Cycle (HCSDLC)

As much as the ideology behind HCSDLC is appreciated for addressing the question around soft human elements within the development life-cycle of systems, it does not give particular attention to the technical aspects of a system development. For this reason, the HCSDLC does not sufficiently

align with the qualities or characteristics of the sociotechnical theory according to the explanation presented by Mumford (2000). The same shortcoming with HCSDLC was noted with the Soft System Methodology (SSM) which also focused its attention on soft issues in system development (Kareborn et al., 2004; Sadath and Gill; 2017).

Notwithstanding the above view, SSM has seven stages which are shown in APPENDIX A, the stages above the line in the diagram (1,2,5,6 and 7 stages) are real world activities that contain people in problem situations. Whereas the stages that are below the line (3 and 4 stages) are activities that think about problem situation (Checkland and Scholes, 1990). Therefore, the SSM does not talk to technical aspects or consideration in the system development process. Which gives an understanding that the SSM system development gives focused on soft issues while neglecting technical issues (Kareborn et al., 2004).

A Sociotechnical system according to Sutcliffe (2000) focuses on the impact of computer systems (technical system) on people and considers ways in which technology can be designed more effectively for people. Therefore, for a system to be considered sociotechnical, it should take into account various social and technical requirements in the system development (Munkvold, 2000; Stahl, 2007; Sadath and Gill, 2017). This view is further supported by Olphert and Damodaran who said *"There is wide acknowledgement in academic and research communities that IS project outcomes are a product of the complex and inevitable interdependencies between the technical and social components of systems" (*Olphert and Damodaran, 2007, p. 2)

According to Adman and Warren (2000), Effective Technical & Human Implementation of Computer-based Systems (ETHICS) is one of the sociotechnical methodologies commonly used within Information Systems. They further clarified that ETHICS incorporates the philosophies of both participation and sociotechnical design. Over the past years, sociotechnical theory has continued to evolve and develop through the work and insights of Enid Mumford and others, for example Clegg (2000), and Klein (2005), Olphert and Damodaran (2007), Sadath and Gill (2017).

The ETHICS methodology is guided by 15 questions (Yaghini et al., 2009). The intention of the method is to develop information systems that are both technically viable, and entail social qualities that would lead to high worker satisfaction (Stahl, 2007; Olphert and Damodaran, 2007; Sadath and Gill, 2017). According to Mumford (1981; 1983) who is the founder of the methodology, the four fundamental objectives of ETHICS are:

1. Encourage participation
2. Improve the general conditions of work under the label "quality of life improvements"
3. Produce systems that are "technically efficient and have social characteristics which lead to high job satisfaction"

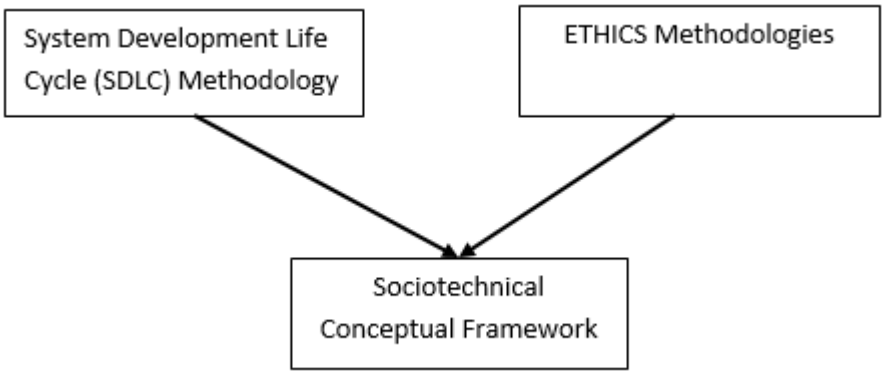
4. Follow the sociotechnical philosophy of trying for joint optimization "making the best use of people, the best use of technology"

While the aim of the ETHICS methodology is not necessarily to produce a computer-based solution, the emphasis is on participative design with an appropriate balance between the social and technical aspects of the complete system (Adman and Warren, 2000). This assertion was later affirmed by Stahl (2007) who argued that to be able to manage change in an acceptable manner, participation of those who are affected by it should be encouraged.

However, ETHICS is mainly criticized for a lack of practical guidance and considerations when developing a system (Olphert and Damodaran, 2007; Hirschheim and Klein, 1994). According to Adman and Warren (2000) ETHICS seems more an embodiment of a philosophy or a position. Furthermore, in their case study, they found that it is feasible to adapt ETHICS and deviate from some of its guidelines while remaining within its overall principles. For this reason, ETHICS alone is not effective in guiding the system development process.

The gaps in the SDLC as discussed together with the merits of ETHICS around stakeholder participation to address social and technical requirements gave rise to the sociotechnical conceptual framework as illustrated in figure 1 below.

Figure 1: *SDLC, ETHICS and Sociotechnical Conceptual framework*



The SDLC methodology is used to give a systematic process and structure, whereas ETHICS is used to address user participation and sociotechnical system requirements. However, the above integration of SDLC and ETHICS should be understood within the context of it being a framework, not a methodology.

According to FEAF cited in the paper by Lakhdissi and Bounabat (2011) a methodology is *"A documented approach for performing activities in a coherent, consistent, accountable, and*

repeatable manner" whereas a framework is *"A logical structure for classifying and organizing complex information"*. In addition a framework can also be viewed as a mechanism for simplification. Therefore, based on the above understanding of a framework, the suggested sociotechnical conceptual framework is a systematic structure that combines phases of the SDLC to understand the development process and the ETHICS methodology for the sociotechnical requirements.

Table 1 below illustrates how the different phases of SDLC and ETHICS were integrated to form the bases of the sociotechnical conceptual framework. The names of the SDLC model are used in the sociotechnical conceptual framework to maintain the originality of the SDLC wording, however a few tweaks have been made to accommodate elements of a sociotechnical approach.

Table 1: SDLC, ETHICS and Sociotechnical Conceptual Framework

No	SDLC model	ETHICS Methodology	Sociotechnical conceptual framework
1	Planning	1) Why Change 2) System boundaries 3) description of existing system 4, 5 & 6) definition of key objectives and tasks	System Planning and Analysis
2	Analysis	7) Diagnosis of efficiency 8) Diagnosis of job satisfaction needs 9) future analysis 10) Specifying and weighting efficiency and job satisfaction needs and objectives.	
3	Design	11) The organizational design of the new system 12) Technical Options 13) Preparation of a detailed work design	System Design and Development
4	Implementation	14) Implementation	System Implementation
5	Maintenance	15) Evaluation	System Monitoring & Adaption

In the proposed sociotechnical conceptual framework as illustrated in APPENDIX B combines the 'System planning and analysis' steps of the SDLC because they are directly interlinked. Since ETHICS is mainly constituted of the 15 questions to guide the process, question 1 to 6 of ETHICS was categorized under system planning while question 7 to 10 was categorized under system analysis.

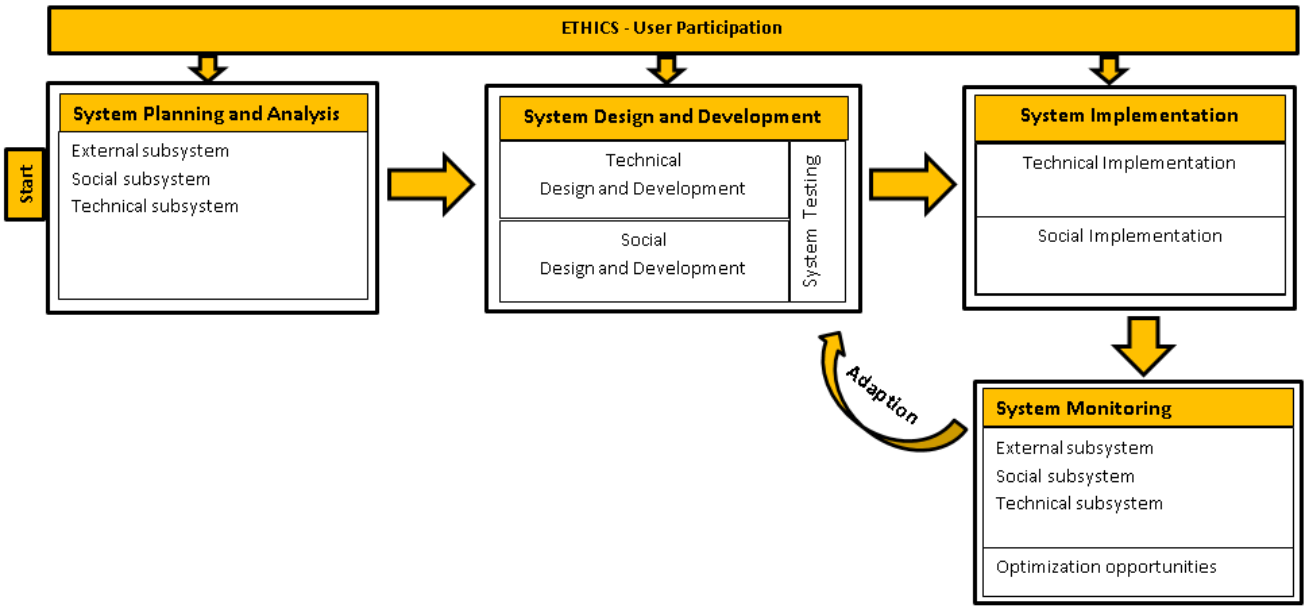
Thereafter, question 11 to 13 of ETHICS was categorized under 'System design and development'. Question 14 was directly categorized under 'System Implementation' and question 15 under 'System Monitoring & Adaption'.

According to Patnayakuni and Ruppel (2008), a system development process can be conceived as a work system whereby developers build information systems using organizational resources, which include human resources (i.e. skill and knowledge) and technological resources (i.e. development tools and the IT infrastructure). The sociotechnical conceptual framework also follows the above system development principles; however it also incorporates a sociotechnical dimension to the approach.

3.2. Phases of the sociotechnical conceptual framework

As discussed in section 3.1 above Figure 2 below illustrates the sociotechnical conceptual framework which is informed by both SDLC and ETHICS methodology. This section discusses in detail the different stages of the sociotechnical conceptual framework (i.e. 'System planning and analysis', 'System design and development' etc.) for understanding and interpretation purposes.

Figure 2: *Sociotechnical Conceptual Framework*



3.2.1. System Planning and Analysis

In the first box of the sociotechnical conceptual framework which is titled 'System planning and analysis'. There are various methodologies and tools available for organisations to use when conducting the planning and analysis of a system, such as Soft System Methodology (SSM) and Human-computer interaction (HCI).

However to fulfill the planning and design requirements from a sociotechnical perspective, Adeshina and Ojo (2014) have identified three critical subsystems which are External, Social and Technical subsystem. This perspective of three sociotechnical dimensions for the design of a systems is in line with the work of previous sociotechnical development writers (Patnayakuni and Ruppel 2008; Tornatzky and Fleischer, 1990), although their terminology of reference differs slightly. These three dimensions are outlined and discussed below.

3.2.1.1. External subsystem

The external subsystem looks at entities outside the organization, including the regulatory requirements which govern how organizations relate with the society (Adeshina and Ojo, 2014). Government and regulatory compliance has also been noted as an external factor (Wilson, 2000; Moray, 2000; Rasmussen, 2000). In addition, the political and economic condition is also deemed imperative for consideration by Rizzo et al., (2000). Although the political and economic system development factor was only noted in the paper by Rizzo et al., (2000) it will be considered because it gives a different dimension to external factors.

According to Stahl (2007) one of the shortcomings of ETHICS done by Mumford is that she did not thoroughly consider that organizational processes were shaped and influences by various external powers which includes government and competitors. As such, based on the literature review, external factors such as political and economic environment, rules and regulation, market conditions and external entities (i.e. government and consultants) were noted as significant for consideration during the development of a system (Rizzo et al, 2000; Rasmussen, 2000; Wilson, 2000).

3.2.1.2. Social subsystem

The social subsystem encompasses elements such as employees, knowledge, skills, attitudes, values and other related needs they bring to the work environment which includes how they are rewarded and the relations with structures of authority (Adeshina and Ojo, 2014). Privacy and anonymity were cited as social factors for system development by (Adeshina and Ojo, 2014; Cooper et al., 1996). Furthermore, according to Cooper et al (1996) for a system that is used by the public, there are two main sociotechnical issues that must be addressed which are; the protection of users privacy and misuse of personal information.

Based on the literature review, social factors such as top management support, Organizational structure and policy, appropriate IS Staff, User participation, Privacy and anonymity were noted as significant for consideration during the development of a system (Fowler, 2007; Carayon, 2006; Moray, 2000; Nandhakumar, 1996; Cooper et al., 1996).

Notwithstanding the understanding above, the paper by Sharma et al (1991) argues that management interest has grown from just monitoring employment levels and organizational output to include: factors affecting the utilization of machines by people, managerial power and decision-making, impact on organizational design , intra- and inter-organizational communication , job characteristics, computer mediated work, gender, age, office-type and attitudes towards computers, and causal relationships between technology and organizational structure.

3.2.1.3. Technical subsystem

The technical subsystem comprises the hardware, tools and expertise needed to process inputs of the system to outputs that meets the desired aims of the system (Adeshina and Ojo, 2014). System integration was cited as technical factor for system development (Patnayakuni and Ruppel, 2008; Carayon, 2006)

Based on the literature review technical factors such as technical resource allocation, system security, system integration, and technology infrastructure were noted as significant for consideration during the development of a system (Patnayakuni and Ruppel, 2008; Carayon, 2006; Nandhakumar, 1996; Rainer and Watson, 1955).

3.2.2. System Design and Development

The second box of the sociotechnical conceptual framework is titled 'System design and development'. The process of involving both social and technical aspects in the design of a system is considered to conform to the sociotechnical principles (Fowler, 2007; Cooper et al, 1996). The aim of the sociotechnical development is to realise a *"joint optimisation"* which is the social and technical apparatuses working together to achieve a given system objective or state (Stahl, 2017; Trist, 1981).

The solution that is developed as a result of the sociotechnical development outcome is the information system artifact for which in our context is the online application system. At this point the application should be developed with both social and technical requirements as noted in the planning and design phase of the sociotechnical conceptual framework aided by user participation to ensure integration, cohesion and acceptance.

According to Clegg et al. (1997) one of the major considerations for increased levels of IT system failures is the insufficient attention given to people and related organizational aspects which results due to poor management, ambiguous user requirements, insufficient project management practices, business needs and goals disregarded, and exclusion of users participation.

3.2.2.1. Technical Design and Development

Technical development at this level should take into account all key technical issues raised and captured during the design of the system and ensure they are addressed during development. The paper by Goodhue (1988) argues that the people that manage and use the system should be happy with it and further added that a *"good"* system must one that had great architecture and performance which includes the system knowledgebase, inference engine, explanation facility and user/developer interfaces.

3.2.2.2. Social Design and Development

While the importance of an efficient, accurate and reliable technical systems is acknowledged, the delivery of well aligned and value-adding business solutions should not be seen as 'technical wizardry' alone (Dvorak et al., 1997). Social development at this level should take into account all key social issues raised and captured during the design of the system and ensure they are addressed during development. This is inclusive of the external environment factors such as regulation, rules and government policies amongst others.

Furthermore, literature indicates that the involvement of users in system design activities of a system development and the continuous engagements between customers and the organization are imperative in the sociotechnical system development process (Fowler, 2007; Carayon, 2006; Pasmore and Sherwood, 1978).

3.2.2.3. System Testing

According to Tsai et al. (1997) testing is a technique used to validate processes or functionality. The inability to predict and manage impacts of IT investment in the organization is one of the main reasons that results in high levels of system failure (Doherty and King, 2005). It does not matter how good your selected methodology is when you test an application, there is still a need to rigorously test data to prove that is fault-free.

3.2.3. System Implementation

The third box of the sociotechnical conceptual framework is titled 'System implementation'. During the implementation stage, issues of participation, feedback, training and learning, project management, organizational support and management commitment are important to facilitate and foster the implementation of the change (Karsh, 2004; Carayon, 2003; Smith and Carayon, 1995). For this reason the below factors were identified as important for consideration with reference to other authors.

3.2.3.1. Technical implementation

Critics of ETHICS say the methodology does talk about system implementation but it does not give a practical direction or understanding on how it should be implemented (Adman and Warren, 2000). Based on this understanding, technical implementation in this context refers to the deployment of the system to the production environment and the integration with other related systems.

3.2.3.2. Social implementation

According to literature, users and staff should be prepared to better handle the implementation of a system (Karsh, 2004; Carayon, 2003; Knapp, 1955). As part of deploying the new system users should be sufficiently trained on the system for them to understand the purpose of it and how to use the system as an enabler for their day to day tasks and related activities.

Furthermore, other researchers noted that for system success it is not the technology itself that will be of greatest concern but rather the management of the information and perceptions of security and benefits which will determine its success (Sadath and Gill, 2017; Stahl, 2007; Cooper et al, 1996).

3.2.4. System Monitoring

The fourth box of the sociotechnical conceptual framework is titled 'system monitoring'. The paper by Eason (2001) indicated that organizational issues are tackled in an ad hoc way whenever they emerge, which is often after the system has been implemented. The idea of monitoring and management of the system outcome is informed by the understanding that sociotechnical designs should be flexible to meet changing demands and be compatible with the organization and users' goals (Stahl, 2007, Karsh, 2004).

It is against the above understanding that management must continuously monitor changes in external factors, social factors and technical factors that may seek to compromise the existence of the system. As such, should the need arise the system should be redesigned to adapt to the arising sociotechnical needs as identified when monitoring. Clegg (2000) emphasizes that design is an activity that extends over time, and continues beyond system implementation and throughout use: "the people using the new system interpret it, amend it, manage it and make such adjustments as they see fit and/or are able to undertake" (p. 467). The below subsystems were identified as important for the 'System monitoring' phase:

3.2.4.1. External subsystem

Changes in external entities, rules and regulations, which governs the relationship between the organization and the society at large need to be monitored and adjusted as required to maintain the sustainability and relevance of the system.

3.2.4.2. Social subsystem

According to Patnayakuni and Ruppel (2008) work systems that reflect the application of sociotechnical principles should result in improved process capabilities resulting in performance. Performance may be assessed by the extent to which customers of the Information System Development (ISD) are satisfied with the systems delivered (Finlay and Mitchell 1994). Failure to manage the user satisfaction may lead to users resisting the system because of their own internal factors, poor system design, and the interaction of specific system design features with aspects of the organizational context for system use (Sadath and Gill, 2017; Stahl, 2007; Markus, 1983).

3.2.4.3. Technical subsystem

This looks at factors that do not bring satisfaction to users as informed by their feedback and the general response to the system. System integration as noted by Patnayakuni and Ruppel (2008) is important and other factors such as functionality, system availability, information security, privacy and anonymity can be addressed by Technology innovation (Nandhakumar 1996). Required technology innovation will bring rise to the need to optimize the system with the intent to address the identified gaps.

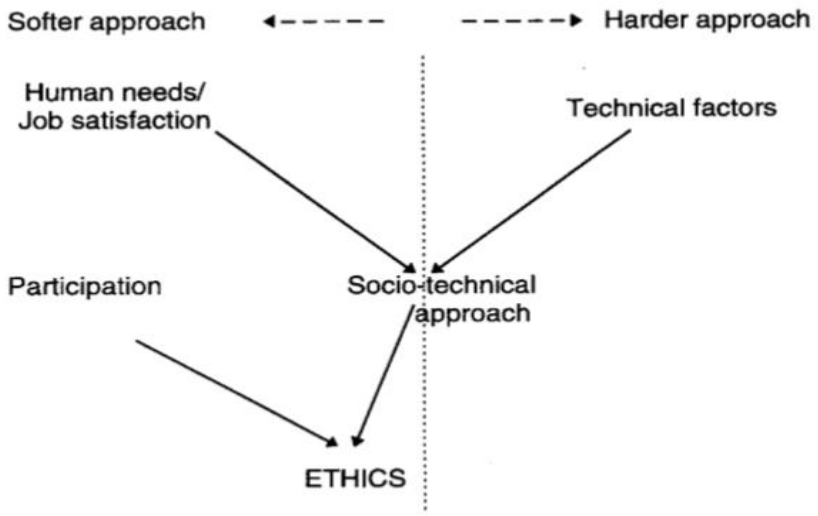
3.2.4.4. Optimization Opportunity

The joint design and optimization of social and technical systems has been and remains rare (Yang at al., 2012; Patnayakuni and Ruppel, 2008; Klein, 2005; Matthews, 1997) hence the aim of the sociotechnical conceptual framework is to achieve a 'joint optimisation' to produce a given goal state.

3.2.5. ETHICS - User Participation

The aspect of user participation (which is the top box that connects with the various stages of the conceptual framework) is the touchstone in ETHICS methodology. As such, ETHICS is addressed through various mechanisms such as design groups, steering groups and project teams (Adman and Warren, 2000; Olphert and Damodaran, 2007). Failure to incorporate users in the system development process will later cause problems to the users when using the system (Singh and Kotze, 2003; Yang et al., 2012; Sadath and Gill, 2017). As illustrated in figure 3 below, when you incorporate social and technical aspects in the development method one should have participation from key role players such as users. This is at the core of the ETHICS user participation.

Figure 3: *Methodological interrelationships (Adman and Warren, 2000)*



Failure to involve participants in the system development process may affect workplace productivity, social relationships and the overall wellbeing of users (Klein et al, 2002). This assertion was later affirmed by Stahl (2007) who argued that for one to manage change in an acceptable manner, participation of those who are affected by it should be encouraged. He further added that participation in decision making, in particular regarding the design and use of technology, should lead to greater employee satisfaction and higher productivity, and better use of local knowledge, thereby furthering employers' goals.

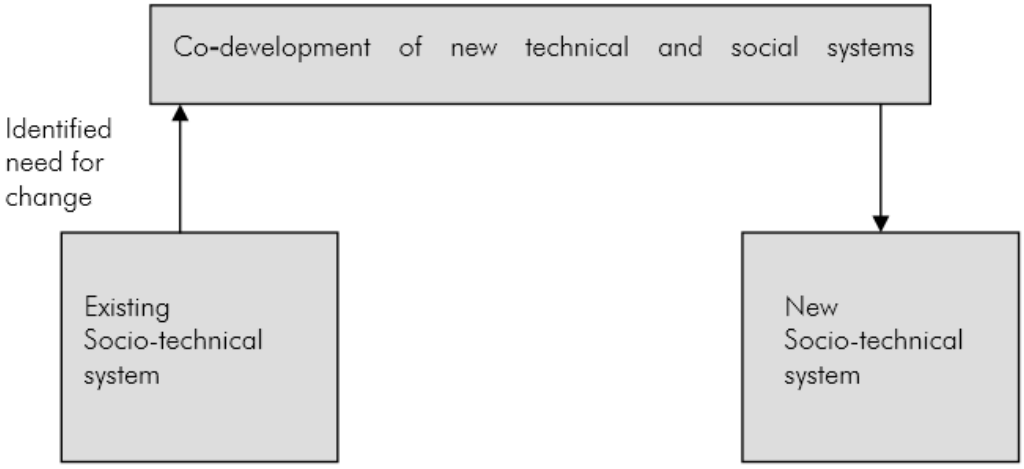
Notwithstanding the understanding above, Butt and Ahmad (2012) found that 96.7% of the experts who participated in their study say that customers should be engaged in SDLC and 90.4 also say that user participation is very essential in the system development process. In addition, literature of previous studies that looked at the impact of user involvement in the information systems development process found that the more user involvement in the system development process, the greater the chances of a successful system (Yang et al., 2012; Stahl, 2007; Gulden & Ewers, 1989)

3.2.6. Adoption

The System monitoring stage above requires that the social and technical aspects of the system are monitored together with any requirements from the external subsystem for review of the existing system. This is mainly because there is wide acknowledgement in academic and research communities that “IS project outcomes are a product of the complex and inevitable interdependencies between the technical and social components of systems” (Klein, 2005; Olphert and Damodaran, 2007; Sadath and Gill, 2017). As such, the online application system

should be monitored and redesigned where required. Figure 4 below gives an illustration how it is done using a sociotechnical approach.

Figure 4: *A sociotechnical approach to IS Design (Olphert and Damodaran, 2007)*



4. Research methodology

Research methodology refers to the detailed procedures to be followed to realize the research objectives (Oso and Onen, 2008). As such this section discusses the details of the methods that were employed to answer the research questions and to address the research objectives. This particularly looked at details relating to the research approaches, research design, geographical setting of the study, sampling techniques and research instrumentation amongst others.

4.1. Research Paradigm and Approach

There are two main paradigms or philosophies in Information System (IS) research; these are positivism and interpretivism. The positivist researchers believe that the world is external and that there is a single objective reality to any research phenomenon or situation regardless of the researcher's perspective or belief (Carson et al., 2001). Whereas interpretivist researchers believe the reality is multiple and relative (Hudson and Ozanne, 1988). Furthermore according to Carson et al. (2001, p.5) the knowledge acquired in this discipline is socially constructed rather than objectively determined. In general terms, interpretivists avoid rigid structural frameworks such as in positivist research and adopt a more personal and flexible research structures (Carson et al., 2001).

Based on the above understanding, this study followed an interpretivist paradigm to study the online application system development from a sociotechnical perspective. Neuman (2006) argues that the purpose of conducting research by using an interpretive paradigm is to be able to understand how people construct meaning in a natural setting through direct detailed observation

by the researcher in the field. As such, the study looks at people's perception and opinion on the system development process and in particular how technical and social aspects played a part in the outcome of the system.

Furthermore, the proposed sociotechnical conceptual framework as discussed in section 3 was deductively applied to the research context with the aim to test its relevance and to understand what sociotechnical issues were at play. Subsequent to that, the sociotechnical conceptual framework was revised inductively based on emerging themes from the research context which were used to build on the existing literature.

4.2. Research Design and Methodology

This study followed an exploratory case study to understand the sociotechnical considerations in the university and what their implications were, if any. A case study research is a well-known methodology (Yin, 2009). Furthermore, an exploratory research is conducted when there are few or no earlier studies to which we can refer for information about the issue or problem (Collis and Hussey, 2009). For this reason, an exploratory research design was used to gain a better understanding of how sociotechnical issues play out in the development of the online application system. The study was specifically using a university case to determine the sociotechnical considerations taken into account and the context of any inclusion or exclusion.

According to Saunders Lewis & Thornhill, (2009) the exploratory research design is used on small sample sizes and uses qualitative methods. Through the exploratory approach, the study discovered and reported the relationship of the different aspects of the sociotechnical conceptual framework and also enhanced it in line with emerging themes that were not covered by literature. This is also known as formulative research for areas that have not been studied or examined previously (Kothari, 2004).

4.3. Data Collection Methods

In order to understand the sociotechnical considerations for the development of the online application system, the study leveraged multiple sources of evidence which were interviews, documentation, and the actual online application system that was developed. The research evidence was collected with a view to answer the research questions and realise the research objectives. The below detailed methods was employed to collect data. In the context of the paper by Walsham and Sahay (1999) below are the detailed data collections methods employed for the research:

4.3.1. Interviews

An interview is a scheduled set of questions administered through verbal communication in a face to face relationship between a researcher and the respondents (Kothari, 2004). A semi-structured

interview was conducted with 8 participants which took an average of 50 minutes each. These participants were key role players in the development of the online application system was conducted to examine their role and views on how the sociotechnical requirements were considered in the life cycle of online application system development. These participants included the system sponsor, Project Manager, Developers, testers, and System manager that were involved in the development of the online application system.

The interview questions were developed in relation to the research questions and the various components of the sociotechnical conceptual framework (i.e. system planning, sociotechnical development, implementation and monitoring) for more detail refer to APPENDIX C. In addition, extensive notes were taken during each interview to ensure that all key points and issues were captured. However, for further requirements or detail a follow-up call and/or email was dispatched to the participant, which was mainly based on their availability and convenience.

Additionally, the researcher used a tape recorder during the interview session to ensure no key information gets omitted. However, the confidentiality and anonymity of the participants was assured to ensure that participants are not inhibited in their opinions while being recorded. The interviews took an average of 50 minutes with each participant identified (refer to table 2 for the list of participants).

4.3.2 Secondary data sources

The data that was collected from the interview served as the primary source of evidence for the study. This was based on the understanding that this evidence was the most useful and the richest source of information regarding how the sociotechnical considerations played-out in the online application system development.

However, other secondary data such as system requirements specification, system issue register and follow-up emails were considered to supplement the findings of this study with context and also to aid the triangulation of our findings. However, for data protection and related security reasons the researcher could only view the requirements specification document and the system issue register. Notwithstanding that, the secondary sources was used to verify, relate and justify some of the information that was received via the interviews.

4.3.3 Sampling strategy

The sample should represent the actual characteristics of the whole population involved in a study (Cohen et al., 2000). The people that were sampled in the study are people who were involved in the planning and development of the online application system from Phase 1 to 3. These people

have been categorized according to their roles and contribution in the project (i.e., project manager, developers, and testers) as noted the table below:

Table 2: Participants for the interviews

No.	Identified interviewees per their role	The phase the interviewee participated in	Role description
1	Student Enrolment Centre	Phase 1, 2 and 3	The main sponsor and owner of the online application system.
2	System Support	Phase 2 and 3	Provided system testing and support for the central student system. And participates in the system development process for data collection, meeting project requirements, dealing with system issue resolution.
3	System Development 1	Phase 2	Programed, deployed and enhanced the Online app to meet business requirements.
3	System Development 2	Phase 2	Programed, deployed and enhanced the Online app to meet business requirements.
5	Quality Assurance (QA)	Phase 2 and 3	To test the system before any deployment to production. This ensures that all integrations, functionality and related items are tested so business is not impacted.
6	Central student system Owner	Phase 1, 2 and 3	Manages all development and deployments on the central student system which includes the new online application system.
7	Project Manager	Phase 3	Managed the project of developing and implementing the new online app
8	Senior Project Manager	Phase 3	Coordinated project governance and provided oversight over the “5 big” projects of the University which included Online Apps

The above sample was purposively selected with the understanding that they were more involved in the online application system project, as such more depth and rationale could be obtained from them. Additionally, these participants were identified on the basis that they played a role in one or more of the components of the sociotechnical conceptual framework being assessed. For example, in the ‘System planning’ phase the system sponsor representing the enrolment center would be more likely to be involved whereas in the ‘System development’ phase, the developers will be more likely to be involved.

4.4. Data analysis process

Upon collecting the data, the researcher analysed the data to answer the questions and research objectives using systematic analysis, which is designed to examine and analyze the recorded information based on relevant themes and categories (Silverman, 2001). Six themes were identified with reference to the stages of the sociotechnical conceptual framework. Which are ETHICS user participation, System planning and analyses, System design and development, System implementation, System monitoring and lastly, Adoption. Furthermore, 14 subthemes were identified and categorised in line with the six main themes.

The researcher analysed the raw data and employed an open coding technique to label each utterance from the interviews and secondary data. Refer to APPENDIX F for more details of the codes developed and used for this research. With the existing themes, components and factors of the sociotechnical conceptual framework deduced from literature; the utterances of the participants in the interviews were coded on Microsoft Excel, and linked back to the proposed conceptual framework. This approach allowed the researcher to categorize, synthesize, search for patterns and interpret the data that have been collected (Miles and Hubberman, 1994).

Subsequent to coding the raw data, the coded data and themes were revisited to establish any concepts or factors that emerged different from what was found in literature. The thematic data analyses method was used to identify, analyse and report patterns (themes) of the data obtained (Braun and Clarke, 2006 p.79). As such, the identified sociotechnical considerations, issues and implications were analysed and reported for the three developmental phases of the online application system.

In addition, observation of the system specification document and the issues raised via the central Incident Management System were used to aid the explanation of the sociotechnical issues and implication. Furthermore, APPENDIX D was used as a guide for giving the researcher a view of what sociotechnical factors or aspects to anticipate in the study, however the researcher was open to new information in the analyses. Notwithstanding the above view, emerging themes were identified and used to enhance the sociotechnical conceptual framework for a meaningful contribution to the existing body of knowledge.

4.5. Research evaluation (Demonstrating Credibility of Findings)

The legitimacy of the research study was demonstrated by evaluating the internal and external credibility of its findings. Internal credibility can be defined as the true value, applicability, consistency, neutrality, dependability, or credibility of interpretations of the phenomenon being studied. Whereas external credibility, refers to extent in which the findings in the study can be generalized to different population or situations (Onwuegbuzie and Leech, 2007). Furthermore, according to Mason (2012, p. 188) to prove trustworthiness one must satisfy themselves and others that they

have not invented or misrepresented their data, or been careless and slipshod in their recording and analysis of data. As such, the discussion below details how trustworthiness, internal and external credibility was achieved.

The interview transcriptions of the participants (who were key role players in the development of the online application system) were examined to determine common sociotechnical issues findings and to establish the system development method used for the online application system. In addition, a review of similar studies was conducted to examine if the findings by other researchers were consistent with what was found in this study, therefore this internal credibility approach aided the study with consistency of the case interpretation, the applicability of the proposed sociotechnical conceptual framework and the credibility of the findings in the study. Furthermore the above approach validates the trustworthiness of the findings.

A number of researchers that studied tertiary online application systems predominantly focused on the benefits and impact of automating the manual application process (Agwa-Ejon and Pradhan, 2017; Bemile et al. 2014; Farhan, 2014; Bharamagoudar et al., 2013). In recognising this view, external credibility or generalizability is different in an interpretative study because one cannot generalise to an entire population using one case. However, based on the literature review that informed the development of the sociotechnical conceptual framework the applicability of the framework was tested and enhanced to make the framework more robust and relevant. The results of how the components of the conceptual frameworks played out in the case study was generelised based on the concept of analytic generalization whereby *"the investigator is striving to generalize a particular set of results to some broader theory "* (Yin, 2003, p. 37). Additionally, previous studies on software development and the reasons that lead to their failure were examined to determine if they can be related to sociotechnical issues. This also address external credibility, or generalizability of the recommendations that emerge from this case study.

4.6. Ethical issues

4.6.1 Voluntary participation and harmlessness

When conducting the study to find out how the sociotechnical approach played out in online application system development, participants were informed that they can withdraw from participating in the study at any point. All participants of the study were not victimised in any form as a result of the information they shared in the study. To solidify this understanding, informed consent which details the above perspective was a prerequisite from participants to confirm they understand their role in the study and what the study seeks to achieve, which enabled them to participate knowingly.

4.6.2 Anonymity and confidentiality

To protect participants from anonymity, there was no identifying information or data could be associated with the audio recording of the interview or the interviewees them self. Additionally, all the data will be made available only to the authentic researchers to analyse and the data is secured and protected from perpetrators through passwords and other related restrictive measures. Furthermore, the participants will not be personally identified in any report or publication work which covers the results of this study.

4.6.3 Disclosure

Prior to conducting the study, participants were informed of the proceeding and objectives of the study so that they understand the value and contribution of their participation in the study (refer to Appendix G). And most importantly, they participated knowing all dynamics of the study. However, the researcher did not specify the information that may result to a bias in the study for example, stating upfront the theoretical significance of considering social and technical requirements for online application system development.

4.6.4 Analysis and reporting

When analysing the data to determine the assertion or findings of the study; the research will not fabricate data to align to their thinking and theoretical assumptions that existed prior to the study. Additionally, the findings were not presented in a way that could identify the university or the participants of the study to maintain confidentiality.

4.6.5 Incentives

If it is an organisation process, standard or expectation for sociotechnical requirements to be taken into account for any system or software development, the result of my study may result in none compliance by the project managers and developers which may result in governance implications. As such, no incentives of any form or type will be allowed to influence the outcome of the study. Additionally, no privileged information was accepted through special arrangements that the researcher may not be allowed to disclose as a researcher, even if the information is profound to the study because the integrity and objectivity of the study may be compromised.

5. Case Narrative and Interpretation

In the introductory chapter an argument was presented that the SDLC model is not sufficiently addressing human-centered issues such as user experience, user participation and other related social aspects (Delavari et al., 2011; Zhang et al., 2002). Whereas ETHICS is mainly criticized for a lack of practical guidance and considerations when developing a system (Olphert and Damodaran,

2007; Adman and Warren, 2000; Hirschheim and Klein, 1994). These gaps or critics noted by research led to the proposal of the sociotechnical conceptual framework which was formulated based on the merits of both the SDLC and ETHICS methodologies. This section presents the background of the case, the applicability of the sociotechnical conceptual framework to the case and a narrative of how sociotechnical issues played out according to the sociotechnical conceptual framework.

Below is the structure of how the section is organized.

- ***Section 5.1*** Narrates how the online application system started, the issues encountered and how they were handled.
- ***Section 5.2*** describes the three development phases the online application system went through and what led to moving from one phase to the next.
- ***Section 5.3*** Establishes and narrates the applicability of the conceptual formwork based on the case context and the methodology used to develop the online application.
- ***Section 5.4*** Narrates the various sociotechnical issues noted in the phases of the online application system and they are organized according to the stages of the sociotechnical conceptual framework.

5.1. Case context and background

The enrolment center of the university manages applications for both undergraduate and post graduates. Before the introduction of the online application system there were only four data administrators in the team who were at the time responsible for capturing information detailed in the application forms. In 2012, an estimation of 70 thousands undergrad applications and a further 25 thousands postgrad applications were received for capturing and processing. This was too much for the team to handle which made them susceptible to mistakes hence the department had to find a way to allow applicants to do some of the capturing.

Student services are the *"administration backbone of higher education"* and are often the first and last contact points for students (Voorhis and Falkner, 2004). This university case study was no exception as they embarked on an online application system which was envisioned to automate the application process and to address all inefficiencies that came with the existing manual process of capturing student information and servicing students.

Furthermore, the purpose of the online application system was to enable the university to efficiently process more student applications for both academic and residential purposes. The system included functionality that enabled students to self-service themselves remotely on the various offerings of the university. Although, students would be further verified manually by internal staff, the system

filtered qualifying students based on mandatory fields (i.e. ID, highest level of study, marks) and other related critical information required for admission.

The online application system of the university was first introduced in 2012 and the approach then was to automate the application form as it was and have the information stored in a database for processing and other related requirements. At the time of the study, it was noted that the online application system (which was on Phase 2) was handling 80% of the applications online via the application system. Notwithstanding the above understanding, over the years, the online application system proved to be problematic because it was configured outside the central student system. As such, there was a huge reliance on the integration layer for data exchange between the online application system and the central student system. This problem was further exacerbated by the resignation of the key developer behind the online application system who left the university.

In an attempt to ensure continuity of business operations in the enrolment center through the online application system, new internal resources were appointed to deal with all issues and enhancements of the online application system. Following the mandate given to the new system developers, the team corrected a number of issues as they related to the online application system and also implemented enhancements to improve the functionality and efficiency of the system. However, the interfacing issue between the online application system and the central student system still persisted. This was mainly due to architectural differences in technology between the two systems, lack of detailed specification and differences in data structure or formatting - System Developer (C).

After various attempts and interventions to correct the interfacing issue, the university management resolved to invest in a new online application system that would be built on the central student system to address the interfacing issues and other inefficiencies experienced. Due to limited capacity and resources internally, an external vendor was appointed to develop the new online application system.

The online application system as a project was managed by internal resources from the project management office. Seemingly, the online application system was one of the ‘Big 5’ projects of the university which included an upgrade to the Residence system, an upgrade to Oracle, Fees Estimator, Activity Management and online application system.

The sections below give an account of how sociotechnical aspects played out in the development and implementation of the online application system from inception until the time where it was developed by the external vendor.

5.2. Phases of the online application system

According to the case narrated in section 5.1 above, there are essentially three development phases of the online application system which are detailed below.

Phase 1: This is the inception of the online application system where the paper form of the university application was automated for applicants to populate their information online for the enrolment center to process and reply. *"The first online application system which is the current one that we are about to replace, we literally took the paper form and then we said how do we create an electronic version of this and we let the applicants apply"* - System Sponsor (A). As such, Phase 2 came about as a result of appointing new developers to continue maintaining the online application system.

Phase 2: This was the continuation of the Phase 1 online application system following the resignation of the key developer of the online application system who understood the setup, configuration and architecture of the system. *"The initial online application system was first created by the developer in phase 1 then there were requirements along the way and a few things that they did not consider back then that are important in the process, so I think after the developer left business has to continue, so Phase 2 developers came and dealt with the enhancements but to a point where most things were redone"* – Quality Assurance (E).

Phase 3: *"The University saw a need to enhance the system and then the requirements were mapped and reengineered, requirements were gathered and referred to the business then processed to the enterprise architecture. Who then appointed the service provider"* - Project Manager (G). This is the phase where a new online application system was built from scratch on the central student system. The development was done by an external Service provider who was appointed to address the various issues the system had i.e. interfacing issues, user friendliness, inconsistent look and feel etc. Other frustrations that lead to Phase 3 as stated by the enrollment center was that *"when the Online application system and the Central student system are not in sync you would have all kinds of errors and it's very frustrating for applicants the system was not an easy user friendly system, whereas what they were currently developing in Phase 3 was within the same platform as the central student system"* - System Sponsor (A).

5.3. Applicability of the case to the sociotechnical conceptual framework

In Phase 1 of the online application system, it was unclear which system development method was used because there was only one person that was assigned with the task of developing the system and he left the University. The requirement from the enrollment center then was that the developer should convert the paper form of the application to an electronic form. As such, from an application development point of view, there was limited interaction between the developer and stakeholders based on the nature of the requirement.

The online application system had a number of technical issues, so Phase 2 came following the resignation of the developer of the first online application system. The main role of the new developers appointed was to do enhancements on the system to address the interfacing issue, system issues raised by users and to attend to any additional requirements needed to make the system more efficient. Furthermore the developer stated that *"they used a hybrid, the reason being that they were not developing something from scratch, they were pretty much redoing a well-defined system so they did not need to go through the old waterfall methodology"* – System Developer (C). Therefore, they developers followed an agile approach towards developing the online application system as they were moving between developers and users and at that time did not have a QA team. In addition, 'Adoption' in the sociotechnical conceptual framework demonstrates that there is no need for one to go back to System Planning and Analyses to accommodate continuous enhancements (which makes it agile or hybrid).

Notwithstanding the above understanding, in Phase 3 of the online application system, the Project Manager affirmed that the principles of the SDLC model were followed as a guide for system development. Furthermore the Project Manager indicated that they followed SDLC, in particular there were 5 stages namely *"Initiating, Start-up, Execution, Monitoring and control and lastly Close-out"* – Project Manager (G). This development model or approach was further reaffirmed by the system quality assurance resource who confirmed that they *"still pretty much used the old waterfall sort of model of system development, where the system has to be fully developed before it goes to testing until that they don't test in bits like your agile approach"* - Quality Assurance (E).

Based on the above understanding it is clear that the sociotechnical conceptual framework which is grounded on the SDLC model is applicable to the case. In addition, in each step of the sociotechnical conceptual framework there will be a narration of how sociotechnical issues played out as they relate to the 3 phases and what the impact they had on the respective stages of the conceptual framework.

Furthermore, details of how user participation was dealt with for inclusivity will be specified in the various steps of the conceptual framework. User participation for this study talks to both the applicants (identified as external users) and the enrollment center together with other participating departments such as fees office, residence (identified as internal users). The project manager indicated that "the online application system does not affect all users, only some departments, such as the enrolment center, residence department, fees office, finance office" - Project Manager (E). These departments are essentially the main users of the system, therefore students are clients in this case. As such, direct system input was mainly received from internal users because it was a challenge to work with external users. The challenge is that in this case the users are mostly

potential students who are applying from outside, so they cannot have active input from them during the development of the online application system.

5.4. Case analyses of the sociotechnical conceptual framework stages

5.4.1 System Planning and Analysis

In the System Planning and Analysis stage, various information gets gathered and used as input for consideration in developing the online application system. The process should involve users or participants as stated by Ewusi-Mensah (2003, p. 48) that user commitment and involvement are critically important in helping to determine what the requirements of the system should be. According to the sociotechnical conceptual framework, the inputs for this stage are categorized as 'External subsystem, Social subsystem and Technical subsystem' which are necessary for a sociotechnical approach for the planning and analysis of a system as discussed in section 3.

External Subsystem

In terms of the External subsystem, in the context of the case, it was noted that there was no input or requirements from any external entity that the system had to conform to or incorporate. However the university strived to strengthen their System Planning and Design processes to protect all customer data which is a requirement derived from the Protection of Personal Information (POPI) act. Notwithstanding the above intention, it was also noted that, at the time of implementing the online application system, the POPI law was not yet enacted by the South African government, therefore it was not yet binding by law. This view was reiterated by the Project Managers who said *"We just need to be cognisant of the POPI act, when we design the system, you know with the POPI act, whatever information that you ask from people, you need to protect it"* - Project Manager (G).

Social Subsystem

For Phase 1 of the online application system there was little clarity in terms of information gathering. This was mainly because there was "one developer whose task was literally to take the paper form of the university application and convert it into an electronic form" - System Sponsor (A). The developer later resigned from his employment with the University. This left a large gap because he was the only one who understood how the online application system was structured.

The above key man dependency issue lead to Phase 2 of the online application system, where two developers were appointed to maintain and enhance the online application system. Phase 2 did not follow the SDLC process for development as it was a continuation of Phase 1 with different developers who mainly did enhancements to address all data and system issues identified. This assertion was affirmed by the developer who said *"they used had a hybrid approach, the reason being that they were not developing something from scratch, they were pretty much redoing a well-defined system, as such they did not need to go through for example the old waterfall*

methodology"- System Developer (C). In pursuit of enhancing and maintaining the Online application system, the below social issues and considerations were noted in Phase 2.

If teams are not on the same page they may end up being frustrated and demoralized to perform their functions effectively. As such, a good relationships was maintained with stakeholders to avoid miscommunication and unrealistic expectations. This was affirmed by the developer who said *"they established a close relationship with the two teams, especially the system support team"* – System Developer (C).

Seemingly, there was insufficient resources to deal with all the issues and enhancement requirements of the Online application system because *"the developers would be swamped with too many unreasonable requests or the business would be laterally unsatisfied that they requested something and it took long"* – System Developer (D).

Furthermore, a lot of discretion and subjective judgment was used in gathering information and planning how the online application system would be approached. This was mainly because *"There were insufficient processes to guide and govern how systems were developed"* – Quality Assurance (E). In addition, *"There was insufficient support from University senior management in terms of investing resources for the online application system"* – System Support (B).

The university was aware that there is always a group that do not have access to the internet and they are not near to the university "to come on campus and apply so every year they print a number of paper forms so when the team liaison do recruiting to various provinces they do package drop-offs at the career presentations" – System Sponsor (A).

All these social issues and considerations articulated above led to phase 3 of the online development system. In this phase, the new online application system was envisaged to address the sociotechnical issues, gaps and considerations as noted in phase 1 and 2. There was consensus amongst the respondents that the Phase 3 online application system received sufficient attention, resources and support. Although at the time of the study, the university was still busy with the implementation of the new Phase 3 online application system, the following social subsystem points were noted in the System planning and analyses stage.

A 3rd party vendor with specialized resources and skills was appointed to facilitate the design and implementation process of the new online application system. The use of a 3rd party was due to insufficient capacity in the university. Fortunately, the project was funded and supported by management as stated by the project manager who said *"This project is one of the projects that senior management had high level interest as it formed part of the Big 5 projects of the university"* – Project Manager (G).

The development of the system was more organized with the project management office involved to ensure good project management governance, clearly defined requirements and monitoring of deliverables in line with the project plan.

Technical Subsystem

In Phase 1 it was unclear whether there was any technical requirement that was considered from the users which formed part of the 'System planning and analyses' stage of the sociotechnical conceptual framework. However, later in the implementation, there was consensus amongst the respondents was that *"there was a persisting interfacing issue with the Online application system and the main central student system"* – System Sponsor (A).

Notwithstanding the above point, Phase 2 was a continuation of Phase 1 from a technological point of view, as such the interfacing issue noted in Phase 1 persisted. For this reason, Phase 2 was technically based on correcting the interfacing issues as and when they occurred and to enhance the existing functionality of the online application system. This understanding was affirmed by the developer who said *"All we needed technically was really to upgrade the technology behind the Online application system and grant the motivation behind the whole idea as it was becoming increasingly difficult to maintain that first version because it was built within certain limits"* – System Developer (D)

In Phase 2, all the system bugs which were inclusive of interfacing issues were logged via a central system and at times an email would be sent to the developers to resolve. This process was followed as and when a technical issue was identified by users or the system support team.

"There was a lot of unreliability of the system in a sense that often because you have two systems talking to each other, they didn't always get it right and they had big data integrity issues" – System Sponsor (A). Due to the persisting interfacing issue in Phase 2, which was identified to be as a result of the online application system being built outside the main central student system. In Phase 3, part of the key technical consideration for the Planning and Analyses phase was to build the new online application on the main central student system. This was envisioned to address all interfacing issues as data is pulled and pushed on the same system or platform.

5.4.2 System Design and Development

In the System Design and Development stage, the system gets designed and developed based on specification to meet the objectives of the online application system. From a sociotechnical perspective the specifications and process should talk to Ethics Technical Design & Development, Ethics Social Design and Development and lastly System Testing as guided by the sociotechnical conceptual framework.

Technical Design and Development

In Phase 1, it was unclear what approach and guide was used by the developer to setup or develop the system. However for Phase 2, the 'Technical design and development' subsystem was mainly informed by the requirements and issues raised by users as and when they occurred. However, developers also added value by proposing certain enhancements based on their experience and system demand identified. These proposals would be discussed and agreed with business for approval. The paragraphs below narrate the technical aspects noted for the 'Design and Development' stage of the sociotechnical conceptual framework.

There was limited technical documentation and records of how the system was setup and incorporated within the broader architecture of the university's technology – System Developer (C). The people responsible for developing and maintaining the system knew how things should be done however the challenge arose when they resign or move with the system knowledge. This made it a challenge to new resources that get appointed because there was insufficient documentation on how things should be done or structures. Furthermore, when new changes were being done, there was no system specifications to guide the requirements of the change. This understanding was affirmed by the developer who said *"we did not follow proper processes in a sense that we never looked at our architectural landscape and we did not have any spec when we start, so to say because it was more like a rewrite so those were some of the challenges"* – System Developer (C).

In Phase 1, an integration layer was developed to facilitate communication between the online application system and the central student system. However, this integration layer brought with it a number of data integrity issues. In phase 2, a number of solutions were developed in an attempt to resolve the interfacing issues. Although the numbers of issues experienced with the interfacing layer decreased significantly, there were still clichés occurring from time to time.

In phase 1, the design of the online application system configuration was structured in a way that when one module was changed, other components were also affected. According to the Developer *"the system in phase 1 was tightly coupled whereby if you change one module it affects everything else whereas ideally a system like that should be loosely coupled such that only one module can be changed without interfering with the others"* – System Developer (D). The view is supported by Aken (2008) who said *"modules should be designed to minimize tight coupling and interdependencies"*. This technical deign issue was addressed as part of Phase 2 enhancements to reduce repetitive issues.

Additionally, the code for the Phase 1 online application system was designed or configured on the front end which exposed to system to hackers and the possibility of data being stolen. Part of the enhancement process in Phase 2 was to develop the code on the back end of the online application

system. *"The new application system, a lot of code now is on the back end and it makes it easy for maintenance and enhancements".* - System Developer (D). In addition, the Phase 1 online application system was using the old version of spring, therefore code was more on Extensible Markup Language (XML) which limited them from doing some of the changes and enchantments in Phase 2.

The online application system in Phase 3 was designed to be a component within central student system. From a technical perspective, this closed the persisting data integrity issue because the system is pushing and pulling data from the same source. As such, there was no need for an integration layer. This approach came with a number of advantages for both the online application system and the people working on it, for example *"if you add the online application system on your central student system and then if one is not available, it means the whole system is down. So even if you had to do maintenance it becomes easier"* – System Developer (C).

Social Design and Development

In Phase 1 of the online application system, the design was based on how the developer wanted it to be. This was mainly because they asked him to convert the paper form of the university application to electronic form. The paragraphs below narrate the social aspects noted for the design and development stage of the conceptual sociotechnical framework.

In the Phase 1 design, the look and feel of the online application system was misaligned with the university look and feel. This was corrected in Phase 2 when enhancements were being made which is confirmed by the developer who indicated that *"For our new Online application system , the look and feel talks to the university website in terms of the look and feel"* – System Developer (D).

A ticket system was incorporated in Phase 2, to ensure that issues and requests were raised via a centralized system for tracking and resolution. Although, at times certain users would send email as opposed to logging the issue via the central system, the developers would log it on the system on their behalf prior to resolving the issue.

At times the developers took it upon themselves to identify inefficiencies on the online application system and they would motivate to business to develop and deploy an enhancement. *"We were looking at how we can design and how easy it can be for us to improve our online application"* – System Developer (C). Notwithstanding that in Phase 1, there were limited resources dedicated to designing and developing the online application system. As such there was a key man dependency on when and how the system would be improved or restructured.

In Phase 2 it was noted that the online application system developers had limited skills, knowledge and capacity to work on the main central student system. Hence the repetitive interfacing issues and delays in investigating and resolving the data integrity issues.

In Phase 2, the online application system used a number of open source material, as such, there was no patent for the codes. This understanding was affirmed by the developer who indicated that *"their system was open source so we still don't have up to now any patent or any technology we would say its sensitive"* – System Developer (C). However, part of the design process was to consider the requirements and approach for testing during implementation. *"QA had to develop the test cases among other things and then make sure that there is test data for testing prior to testing that process or system"* - Quality Assurance (E).

The online application system in Phase 3 was designed to be user friendly and to enable self-service for the users or applicants to access and monitor their application remotely. Part of the design was to include material (i.e. Video) that will be put on the site, YouTube and related platforms to help guide users how to navigate around the system when applying – System Sponsor (A).

System Testing

In Phase 1, there was no dedicated QA team to assist with the testing of the online application system, as such the enrolment center team used to test and determine if the systems works as intended. Whereas in Phase 2, the support team was used as QA to help with testing because they were familiar with the issues faced by users. It was further noted that part of what business support would do is to make sure they create the scenarios, processes and the data to match the process of testing -- Quality Assurance (E). Subsequent to the test, the enrolment center and related stakeholders would be involved in the testing process through doing the User Acceptance Testing (UAT).

The technology infrastructure and setup of Phase 2 did not enable the use of Continuous Integration (CI). The developer indicated that *"Continuous Integration was so important in their environment, because if you change one of the components, the CI environment automatically tests everything for you and alert you if anything else broke after you change any of the existing components"* – System Developer (C).

Although there was no project management resources and practice for Phase 2, testing was considered to be significant for all deployments. This was affirmed by System Support who said "*they made sure that even under tight timelines they do the testing first because moving the code to production without testing it may not necessarily bring problems to the same system, but also break other systems*" – System Support (B).

In Phase 3, the vendor that was appointed to develop the system was required to develop and conduct the system train the trainer program. This meant that internal staff that were going to be training users will first get trained by the vendor on the system and how to train users. The project manager further confirmed that *"after training the trainer they do functional testing which is system based testing, after that we do UAT which is User Acceptance Testing"* – Project Manager (G). All this is done with the objective of ensuring that the integration and implementations of the Online Applications System is as smooth as possible.

5.4.3 System Implementation

After the developers obtain assurance from testing that the system can work, it gets deployed to production for users to access and apply for the various programs they require. Below is a description of the various technical and social implementation considerations and their respective impact on the outcome of the system.

Technical implementation

Little was noted about technical considerations in the interviews. However, from system testing it was noted that the architecture and infrastructure should support the functioning of the online application. Therefore, part of testing is to ensure that the online application is hosted optimally to enable the system to meet its intended objectives.

Technically, when deploying the Online application system to production, the process gets monitored to ensure that any technical delay or challenges get the attention of engineers and other technical resources to resolve timeously for a smooth implementation. This was applicable for all phases of the online application system.

Social implementation

It is unclear what the social considerations for implementation in Phase 1 and 2 were. In Phase 2, developer's deployed functionalities and other related enhancements responding to the requests and issues that were raised by users and business respectively.

However in Phase 3, training was critical as part of implementation to ensure users understood what they were doing. For example, business put together a YouTube video to demonstrate how the new system works and when you want to apply. This video gave a step to step guide on how to apply, which was meant to assist applicants who may be challenged navigating around the system.

To manage the transition from Phase 2 to 3, the developers through the guidance of business had already updated the message on the existing platforms to encourage applicants to apply before the university change over to the new online application system (i.e. Phase 3). The sponsor confirmed

that it was mainly because they had made a conscious decision that they were not going to migrate incomplete profiles from one platform to the other – System Sponsor (A).

5.4.4 System Monitoring

System monitoring is concerned with monitoring any issues and required enhancement post implementation. This is mainly to keep the system relevant and effective in meeting changing user needs. From a sociotechnical perspective changes or requirements are monitored from an external, social, technical and optimization perspective which are unpacked below in line with what transpired in the case study.

External subsystem

There were no external subsystem changes noted from phase 1, 2 and 3. Although it was missioned that the Online Application development for phase 3 took into account the requirements stipulated by POPI, it was however not compulsory for them to comply with as the regulation was not yet enacted. Notwithstanding the above understanding, the system owner noted that changes from basic education does affect the requirements of the university. For example *"If tomorrow the department of basic education were to make a change to the National Senior Certificate (NSC) and change it from 7 to 6 subjects for example, then they would have to change their validations of the system to cater for such changes"* – System Sponsor (A)

Therefore, if there is a change from that space that warrants the university to align with, then that would also affect the online application system because the contents on the system will also have to be changed to align with University amendments.

Social subsystem

This looks at how users received the system and how issues the addressed when raised on the system. This approach is imperative in ensuring that the system remains relevant and effective to users. In Phase 1, one of the issues that was noted was the usability of the online application system. For example, users has to go through two portals to have a complete view of their application, one portal was for creating their profile and the other portal was for the Self Service to view status of the application – System Owner (B). Therefore In Phase 2, various enhancements were deployed to improve the usability and functionality of the online application system. In addition, one of the issues that were noted during Phase 2 was the inconsistency of look and feel between the online application system and the university website. Therefore, this meant that the developers had to develop a solution which aligned to the theme and design style of the university website.

"We have an issues tracking system where we logged everything in and once you get a request we would work on it" – System Developer (D). This statement affirms that through the tracking system

various issues and requests would be noted and a necessary solution would be developed to address the issue or request. However this method only catered for issues or request raised by internal users, such as student enrolment, lecturers, residence etc. To obtain input or feedback from applicants the Sponsor indicated that *"from time to time they obtain completed surveys from applicants who come through the system and we ask them for input not just on the application system itself but also the process"* – System Sponsor (A). This approach enables the university to have a sense of the issues applicants were facing, hence Phase 3 was meant to address all issues which had technological limitations for them to be resolved in Phase 2.

Technical subsystem

"One major issue that we had was integration problem because we pull a lot of data from central student system into online apps and at one point it was a major headache" – System Sponsor (A). This problem was first experienced in Phase 1 of the online application system. Although many attempts were made to correct this technical issue it would still occur from time to time. This was mainly because the online application system outside the central student system as such it required an integration layer. Issues around the integration layer were monitored for any errors which were addressed as and when they are identified.

In Phase 1, the technical setup for how the online application system looked did not enable flexibility in changing the appearance and style of the system. This was affirmed by the developer in Phase 2 who said *"it was a lot of work to change the look and feel alone because a number of things were interdependent so they came up with a look and feel that could be striped and changed anytime the university wanted"* – System Developer (D). This change noted by the developer came as a result of continuous monitoring and feedback from stakeholders.

Furthermore, when enhancements are deployed on the central student system, the impact on the online application system has to be assessed for necessary changes to align with the changes made in the central student system. This understanding was affirmed by developer who said *"central student system support maintain their own product and we maintain our own product so what I'm saying is that it lies between the two teams"* – System Developer (C).

In addition, the developers of the system were not responsible for the infrastructure performance or capacity. As such "if the system was slow it was not really the responsibility of the developers but that of the system engineers in the IT infrastructure team" – System Developer (D).

Optimization Opportunity

According to Oxford dictionaries (2019), optimization is effort or action of making the best of the situation or resources you have, irrespective of the challenges that may exist. As such the intention of 'Optimization opportunity' subsystem is to identify a new method, process or capability to make

the online application system more efficient and effective in serving the users. Whereas, monitoring of Social and Technical subsystems, the intention is to respond to the issues identified as opposed to identify an opportunity to be pursued or optimize.

Ordinarily, system changes are required by business. However in Phase 2 there were various functionalities identified by developers and motivated to business to consider for the online application system based on their experience – System Developer (C). These were optimization opportunities noted by the developers although at times the developers could not develop a solution due to technology limitations.

By the time of the study, Phase 3 of the online application system was still on the Design and Development stage. As such, no optimization opportunity items or projects could be noted. However, through continuous reflection of changing dynamics in the university and society at large, the university should take advantage of new opportunities to make their Online application system as relevant and user friendly as possible.

5.4.5 Adoption

In the adoption stage, feedback or any identified improvement area gets documented and incorporated in a later action during the next iteration design activity (Mahadevan et al., 2015). As such any improvements that were noted are designed or reengineered to be implemented. For example, the look and feel of the system was inconsistent with the university website. Upon this being detected as an issue, a solution was developed to enhance the online system to align to the university website.

5.4.6 Ethics User Participation

Since the inception of the online application system, applicants have never participated in the planning, design, development and/or implementation process of the online application system. This is mainly because most applicants are from high school or others are mere members of society who meet the minimum requirements to apply for a program with the University. At times, this may also be inclusive of already existing students like post graduates.

The paper by Stahl (2007) argues that ETHICS can only be successful in a framework that is conducive to organizational democracy and participation. After reflecting on this view it was noted that in Phase 1 of the online application system there was no interaction with users to involve them and consider their input in the development of the online application system. Hence there was a number of issues that required the attending of the developers to resolve. However, in Phase 2 it was noted that a questionnaire was generally sent to potential students or applicants to obtain their input on what could be done better on the system. This information was used to enhance and improve the functionality of the online application system – System Sponsor (A).

Notwithstanding the above approach for obtaining user input, it was noted that access to these potential students in a coordinated manner was a challenge and having them to contribute on every stage of the system development process was a complex approach. As such, for Phase 1, 2 and 3 of the online application system, internal staff was used to impersonate applicant's requirements. This was mainly because some of the staff members were students themselves, so they would have capacity to know what kind of requirements and functions are necessary for a good user experience. These internal staff or users included the Enrollment Centre, Residence, Finance, lecturers etc. Although participation is encouraged, research also shows that users give input according to their preferences, but they may lack conceptual awareness of possible technologies (Mumford, 2003; Stahl, 2007).

The above internal user participation would be mainly driven by the Enrollment Centre and it gets presented as business requirements for developers to work on. As stated by the Developer *"The business will come with requirements to tell us what they want and it will be between us and them to put together what they call a functional specification"* – System Developer (C). In addition there would be a meeting to discuss and clarify what the business wants. This process enabled the developers to articulate any system limitation in a case that a requirements can nott be met. The paper by Sadath and Gill (2017) indicates that the ETHICS methodology highly concentrates on the design process where users become real partners. Therefore, in Phase 2 of the Online application system participation of users was considered in the development process, even though it was not called ETHICS specifically.

6. Discussion

The aim of this chapter is to provide a discussion on the sociotechnical consideration for developing the online application system together with the sociotechnical issues that arose from the case. The chapter further examines and analyses the implication of the sociotechnical issues and what was done to resolve them. Upon analysing the outcome of the sociotechnical issues, an assertion is made on the usefulness of the sociotechnical phenomenon of as a theoretical lens and the relevance of the sociotechnical conceptual framework as a guide for a sociotechnical system development. This section is organised as follows:

- **Section 6.1** examines the sociotechnical consideration for the online application system and their outcome according to the researcher's interpretation of the case.
- **Section 6.2** identifies sociotechnical issues that arose from the case and discusses their implications.
- **Section 6.3** provides an analyses of the sociotechnical theory based on the case and gives an accession of its usefulness as a theoretical lens.

- **Section 6.4** provides a reflection of the sociotechnical conceptual framework and determines its relevance as a guide for sociotechnical system development.

6.1 Sociotechnical Considerations for System Development

A sociotechnical system development approach talks about the importance of considering Social and technical issues when developing a system (Munkvold, 2000). Although a sociotechnical approach is not prescriptive on what sociotechnical aspects to consider, it emphasizes the point that technical and social aspects of a system are intertwined (Adman and Warren, 2000. Davenport, 2008). Hence with a sociotechnical approach the involvement of users and related stakeholders implicated by the system is imperative in order to proactively detect and address issues that may affect users. Not all considerations or factors noted in the literature appear in the case (i.e. Organizational structure and policy) however some appeared together with emerging factors (i.e. appropriate IS Staff, User participation, management support, privacy and anonymity). Below is a discussion of the sociotechnical consideration noted during the development of the online application system from Phase 1 to 3.

Social Consideration:

One of the key motivators that lead to the first online application system was to increase the efficiency of capturing and processing more volumes of applications. As such, the online application system would allow applicants to do most of the capturing and process or redirect the application to relevant personnel. In following this approach the Enrolment Centre was *"aware that there is always a group that do not have access to the internet and they are not near to the university to come on campus and apply so every year they printed a number of paper forms"* – System Sponsor (A). This is called digital divide which is defined as the gap between those who use versus those who do not use computers and the Internet (Reynolds and Chiu, 2016, Castaño-Muñoz, 2010). So to ensure that the university does not exclude disadvantaged applicants they continued with having the manual process to accommodate the users who do not use or have access to a computer and the Internet.

Disabled people were also considered in the process of developing the online application system. Although the consideration of disabled people was not on the online application system in terms of specialized functionality, the university did have a disability facility with dedicated resources to assist disabled applicants. This facility is called the disability unit *"Where all disabled student or applicants can get support and assistance"* – Project Manager (G).

In Phase 2 of the online application system, the developers could not effectively develop and relate the online application system with the central student system due to limited skills they had on the central student system. As stated by the developer *"they were not specialist on central student*

system, so communicating with central student system was an issue because they do not know what the system accepts" – System Developer (D). For example, to pass a gender from the online application system to the central student system, they would use 'Male' or 'Female' only to find that when passing the data the central student system takes abbreviation like 'M' for male and 'F' for female. In Phase 3 this challenge was addressed through training as confirmed by the project manager who said *"the Service Provider will conduct a training the trainer program to transfer knowledge and skill of the system to internal resources"* – Project Manager (G).

Prior to deploying Phase 3 of the online application system, some applicants were still in the process of completing their application on the Phase 2 online application system. Which meant that they will have to restart the application on the Phase 3 online application system. The enrolment center correctly anticipate the frustration it will cause to applicants and the *"composed a message on the existing online application system encouraging applicants to complete their application before the university changed over to the new Phase 3 online application system"* – System Sponsor (A). This was mainly because the Enrollment center had made a conscious decision that they are not going to migrate incomplete profiles from one platform to the other.

Social considerations such as management support, project management and protection of personal information featured more in Phase 3 of the online application development. For this reason Phase 1 and 2 was impacted by the not incorporating these considerations as was noted in the literature. For example, due to insufficient management support, there was no resources investment to effectively deal with the interfacing issues and project deliverables were delayed due to inadequate project management practices.

Technical Consideration:

The ETHICS methodology expects some conflicts between the social and technical systems (Sadath and Gill, 2017). As such, the development team and participants have to identify and prioritize between both social and technical issues and make compromises where required to make both dimensions workable. The online application system for Phase 1 and 2 was developed outside the central student system, as such there was a need to develop an interfacing layer to enable both systems to communicate. However in Phase 1 and 2 *"there was a persisting interfacing issue between both systems which led to data integrity issues"* – System Sponsor (A). As such this technical challenge had to be resolved in Phase 3 by developing the online application system on the same technology platform as the central student system. System integration was cited as technical factor for system development (Patnayakuni and Ruppel, 2008; Carayon, 2006)

In Phase 3, there were few technical aspects that were considered except for the issues raised from time to time for the developers to develop an enhancement in an attempt to resolve the issue. This

was mainly because many of the critical technical issues they had learned to deal with them in the previous projects that form part of the "Big 5". This assertion was verified by the project manager who indicated that *"The challenges that we had on the 3 completed project of the Big 5 actually helped us to better plan for this online application system hence we don't have much issues"* – Project Manager (G)

According to the literature review, the technical subsystem was more concerned with security, system integration, and technology infrastructure (Patnayakuni and Ruppel, 2008; Carayon, 2006; Nandhakumar, 1996; Rainer and Watson, 1955). Technology infrastructure did not feature a lot because it was managed by the IT infrastructure team. However, there was a consensus amongst the respondents that system integration was a persisting technical issues. Whereas security was a consideration which was noted more in Phase 2. Although various security aspects were considered, there were still gaps mainly because security is multidimensional in nature. The section below is an in-depth discussion of the social and technical issues noted in the study and their implication on the online application system.

6.2 Sociotechnical issues and implications per phase

Although the involved team in the online application system considered sociotechnical aspects that could affect users, they did not pick up everything. As such from time to time enhancements had to be made on the system to attend to any social or technical issues that arose. Furthermore some of the enhancement were initiated by the developer's based on their experience and judgment *"So changes were not always from business, we would make a proposal looking at how we can design and make things easy to improve the online application system"* – System Developer (D). Below is a discussion of the sociotechnical issues that required to be addressed from Phase 1 to 3:

Misalignment of technology, architecture and system structure

In Phase 1, the online application system was developed outside the central student system, which meant that each system was running on its own platform or technology. As such, developers had to develop an interfacing layer to facilitate the communication between the two systems.

The misalignment of technology between the two systems led to repetitive interfacing issues raised which further resulted in data integrity issues on the student application data. This issue was exacerbated when the main developer in Phase 1 left the university. Then the new Phase 2 developers had to learn how the system worked and rewrite it where applicable to address issues identified. This understanding was affirmed by the Quality Assurer who indicated that "After the main developer for Phase 1 left, business had to continue. So the new developers came in and dealt with the enhancements to a point where they had to redo most of the things" – Quality Assurance (E)

The Phase 2 developers indicated that enhancements that were developed were tested however when implemented they broke other systems or functionalities. This is mainly because the technology and architecture of both Phase 1 and 2 of the online application system was not structured in a way that allowed for testing to show how it affected other systems, functionalities or links. In technical software language they say the *"System is tightly coupled whereby if you change one module it affects everything else"* whereas ideally a system should be loosely coupled *"whereby when one module can be changed without interfering with other modules"* – System Developer (D). However in Phase 3, the online application system was built on the central student system, therefore there was no interfacing issues which required testing of interfaces to other systems, links and functionalities.

In Phase 1 the software code for the online application system was sitting on the front end of the system. Which meant that the student data and the online system was vulnerable to hackers and other related cyber criminals. This system issue was noted by the Phase 2 developers who subsequently rewrote the code on the backend to protect and secure the online application system. This accession was validated by the developer who said *"A lot of code of the online application system is now on the back end and it makes it easily for them to maintain the system and deploy enhancements"* - System Developer (D). In Phase 3 of the online application system there was no issues because the system is built on the central student system which has its code in back end already.

For Phase 1 of the online application system, there was a consensus between the System Sponsor and the Phase 2 developers that the look and feel of the online system was misaligned to the university website. This inconsistency was seen to be misleading for the applicants hence the System Sponsor request that there must be an alignment which was later done as one of the Phase 2 enhancements *"Now if you check our new online application system, the look and feel is more like it talks to the University website in terms of the look and feel"* - System Developer (D). In Phase 3, the look and feel was maintained consistent with the university website. This was part of the system specification requirements of Phase 3.

From an infrastructure perspective, the Developers of the online application system were only responsible for developing and maintaining the System. Therefore, if there was any infrastructure or capacity issues noted it was dealt with by the System engineers from the IT team. This scope exclusion was noted by the system Developer who said *"They work on the assumption that System Engineers have already tested the environment and it can scale and the database can perform"* – System Development (C). As such any misalignment or inconsistency of IT infrastructure was outside the scope of the online application developers.

Inadequate governance, limited resources and management support

In Phase 1 there was only one developer working on the online application system, which meant that the load of work relating to the system was centered on the one developer, as such the developer was susceptible to making mistakes. Although in Phase 2 there were three developers working on the online application system the amount of work was still intensive due to the limited resources they had. As noted by the Phase 2 developer *"resources were a big problem, no budget was allocated for the online application system"* – System Developer (C).

The issue of limited resources further meant that developers would perform tasks which were out of their scope or company however they had to do them because the system issues had to be resolved. For example, they would perform requirements gathering tasks which ordinarily should be done Business Analyst. This was further confirmed by the tester who said *"This question of managing requirements gathering requirements usually fall within the Business Analyses of which we didn't have them established"* - Quality Assurance (E). The Developer who aligned with this view stated that *"before they did not have a dedicated QA team as such the developers also acted as QA but now we have a QA team"* - System Developer (D).

Over and above the challenges relating to limited resources as noted in both Phase 1 and 2, there was insufficient governance practices in place to manage how the system was developed (i.e. processes, standards, methodology etc.). As such, issues or challenges with the development of the system was addressed based on subjective judgment. The governance related challenges were noted in both Phase 1 and 2 as affirmed by the Developer who indicated that *"The Developer in Phase 1 had more or less the same problems as them, at least they are three, whereas he was alone. So he was the only person who worked on the system, therefore he was bound to make mistakes"* - System Developer (C).

Mumford (2003 p. 28) indicated that a participative approach could be seen as threatening existing power structures and could be stopped by those authorities. Part of what informed the challenge of Phase 1 and 2 was that there was no dedicated resources, investment and attention from university management on the strategic and operational objectives of the online application system. However this was not the case especially for Phase 3 of the online application system because there was investment and management support to ensure all issues on the online application system was resolved. This understanding was articulated by the System Developer who said *"Now there is a project office, now the right resources are in place i.e. they have the developers, they have the QA team, they have the UAT team they even have a project management team to manage the project"* - System Developer (C). This view was further affirmed by the project manager who indicated that *"The online application system project is one of the project that senior management at high level have interest in. So whatever we doing we have to report to them"* – Project Manager (G).

User participation and involvement for input

Applicants who are the main users of the system were not actively involved in the system development process of the online application system. This was mainly because it was a challenge to coordinate and involve them as they were external to the University. As such, user input was received from academic staff and learners who have gone through the process such as undergrad and postgrad - System Sponsor (A). The enrolment center From time to time, would send surveys to applicants who came through the system to ask them for input not just on the application system itself but also on how did they find the application system, the application decisions, getting decision feedback on time etc. - System Sponsor (A). This approach overtime enabled the Enrolment Center to pick up the frustrations and input of applicants. The study by Olphert and Damodaran (2007) indicated that system that are situated in a wider socioeconomic and political context, are influenced by, citizen perceptions and experiences of the system services. Seemingly the online application system is confined to the academic community which is relatively manageable compared to the public.

According to Sadath and Gill (2017) the ETHICS methodology attempts to increase user participation, interest and commitment thereby reducing user resistance, errors and conflicts if any. As such, it was noted in the case that the approach of using internal staff members did not have any material or reputational impact on the online application system. This was mainly because a lot of the staff members were also students at university, as such they would impersonate a student and give feedback of what they would expect on the system if they were applicants – System Developer (C). This point was further reiterated by the project manager who said *"When they were testing the online application system, they test as if they were the applicant"* – Project Manager (G). Furthermore, if applicants were unsatisfied with the online application system, it would be a challenge for them to organize themselves against the university to make sufficient impact for change.

Notwithstanding the above user participation approach, as part of improvement, the Phase 2 Developer stated that *"the online application system should include a system functionality that allows users to capture comments of their experience and input on the system, that would enable developers to know the expectation from users"* – System Developer (D). Although this was an alternative option to increase user involvement unfortunately it was not in place.

The paper by Mumford (2003) acknowledged differences of interest, she consistently argued that participative action can fulfill the needs of managers and employees at the same time. As such, it was noted that user participation on the online Application development was predominantly done by internal staff members with involvement of managers. For Phase 3 in particular, various relevant staff members were used in the development of the online application system such as Residence

Department, Fees Office, Finance Office and Enrolment Centre - Central student system owner (F). Furthermore, to strengthen cohesion, cooperation and involvement the project management office established a steering committee which met on a monthly basis, in these meeting they discuss and tracked the progress of the project together with additional requirements – Project Manager (G). This is in line with ETHICS requirements because ETHICS addresses participation by setting up a steering group to provide guidelines and a design group to carry out the design process (Adman and Warren, 2000).

Use of Project Management practices and guidance

The paper by Fowler (2007) cited effective project management as one of the significate consideration that can determine the success or failure of a system (Refer to APPENDIX D). Projects are intended to be on time, on budget and on scope however they fail when they do not meet their schedule, cost, scope and respective quality objectives (Wagner, 2016). The development of the online application system, particularly Phase 1 and 2, did not have a project manager or follow project management practices. The development and coordination of the system was not based a predefined plan (i.e. scope, resources, costs) but rather a subjective judgment given the priority of tasks as and when they occur. This approach is contrary to project management practices as noted by the system developer who said *"Their development was never treated as a project, there was no project time line but worked purely on an understanding that by certain date they need to be up and running"* – System Development (C). This view was further supported by the Quality Assauer who said *"There was no tracking of progress daily or weekly for deliverables i.e. someone would say I am not ready check on me in two weeks' time, so there was nothing binding from the onset"* – Quality Assauer (E).

Over and above sociotechnical considerations, not following project management practices to coordinate the development of the online application system showed to have unfavorable repercussions on the system. For example, due to delays by role players in the development of the online application system *"they usually scheduled testing few days before the system goes live and they would realise then that the time was insufficient"* – Quality Assauer (E). This occurred due to poor management of time and deliverables, as a result the testers had little time to resolve the issues identified during testing and the quality of testing got compromised. Which in turn led to a lot of errors after the system went live. Deploying code to production without adequate testing not only does it bring problems to the same system but also break other interfacing systems. Which is one of the key issues identified in the case for Phase 1 and 2.

Based on the above revelation, it was noted that project management as a practice had a bearing on the outcome of the system development and the challenges the system had i.e. interfacing issues and data inconsistencies. The need for proper project management when developing the online

application system was raised by the tester who indicated that *"Project management is important because you become structured in your approach in terms of the way you handle your activities, if you are likely to heat some problems you are able to ascertain them earlier to come up with some intervention that will help you get back on track"* – Quality Assauer (E).

In Phase 3 of the online application system, the Project Management Office was involved and there was a dedicated project manager to oversee and guide the development process by applying project management practices. The role of project management started with the 'Planning and Analysis' for the project – Project Manager (G). However it was noted that within the University there was no methodology that was defined as a standard for project management i.e. PMBOK, PINCE 2. As such, the methodology or framework followed by the project manager was based on their project management experience, professional judgement and discretion– Project Manager (G).

Furthermore, in Phase 3 of the online application system development, there was no key issues noted from a project management perspective. This was mainly because the online application system formed part of the "Big 5" projects of the university which included "the upgrade in the Residence System, Oracle, Fees Estimator, Activity Management and Online application system. However 'Activity Manager' and the online application system were the last two they did, as such, the challenges that project management faced on the first 3 projects enabled them to have a smoother implementation on the last two projects mainly because they corrected and learned from the mistakes experienced in the first 3 projects – Project Manager (G).

6.3 Sociotechnical system development – Useful theoretical lens

Upon examining the sociotechnical considerations and issues as discussed in section 6.1 and 6.2 respectfully, it was noted that not all social and technical aspects can be predetermined as they are dynamic and they change in line with developments in society and technology. As such, it is imperative for one to deliberately consider all possible sociotechnical aspects of a system and involve users to ensure a holistic approach. Furthermore, one should have mechanisms to continuously monitor changing sociotechnical aspects that warrant a new development for enhancement (Adman and Warren, 2000; Davenport, 2008).

Therefore, the sociotechnical theoretical lens is useful in facilitation of a smooth development and implementation of a system. In addition a continuous reflection on the relevance of the system is imperative to identify areas that require enhancements. However, this can be possible if people are equipped with skills and knowledge enable their participation in design and development processes of the system (Olphert and Damodaran, 2007). Furthermore research indicates that ETHICS (which is at the core of a sociotechnical system development) can only be successful in a framework that is conducive to organizational democracy and participation (Stahl, 2007; Sadath and Gill, 2017).

6.4 Reflection and relevance of the sociotechnical conceptual framework

Although there was no evidence to confirm participation or sociotechnical considerations for Phase 1 of the online application system, the system development followed the SDLC principles as confirmed by the tester who said *"They still pretty much using the old waterfall sort of model of system development"*- Quality Assurance (E).

Notwithstanding the above understanding, In Phase 2, the online application system was subsequently subjected to a number of enhancements to meet changing business requirements. However, these enhancements did not follow the SDLC process like Phase 1 (i.e. System planning and Analyses, System design and development etc.). This was mainly because *"the basics for the online application system came from the old Phase 1 system as such they did not necessarily need the system specification to start they enhancements"* – System Developer (D).

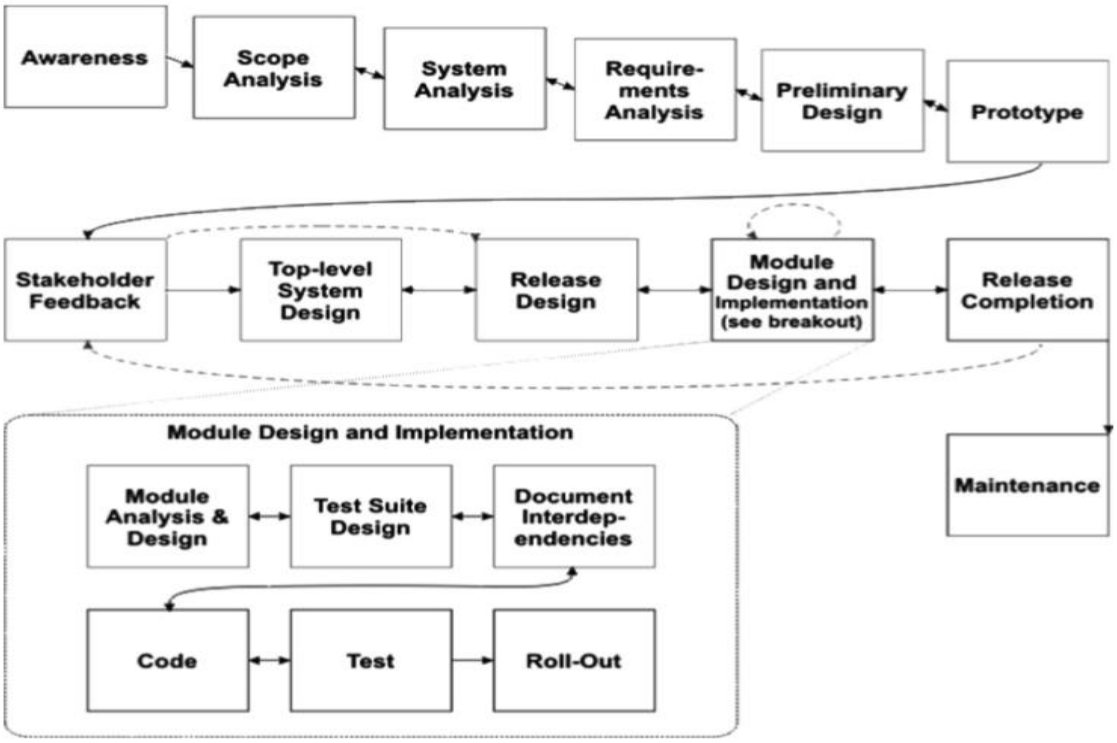
Based on the understanding above, the methodology used to develop these enhancements was agile as confirmed by the developer who indicated that *"they used an agile approach because they were not developing the system from scratch, they were pretty much redoing a well-defined system, so they did not need to go through the old waterfall methodology or SDLC"* – System Developer (C). The paper by Sliwa (2002) argued that in large projects the agile methodology does not scale well, hence a need for a rigorous software analysis and design is required as noted in the SDLC. This view is further supported by Aken (2008) who says the avoidance of a comprehensive requirements analysis component of software development is one of the reasons agile methodologies turn to reduce the likelihood of success for the projects.

The above view by Sliwa (2002) is in line with the evidence of the case because in Phase 3 of the online application system, the system development followed the SDLC principles - Project Manager (G). Mainly because the system was to be rebuilt from start on the same platform as the Central student system. According to Aken (2008) a comprehensive requirements analysis and design reduces overall implementation and maintenance costs. As such, the team had to go through an intensive requirements analysis.

The sociotechnical conceptual framework does align with the above understanding because it is adaptive to accommodate both the SDLC and Agile methodology. However, in the initial sociotechnical conceptual framework provided (refer to APPENDIX B) it was not explicitly illustrated and stated like the revised sociotechnical conceptual framework as noted the Figure 3. For example, for agility if there is any optimization opportunities or new system requirements, through the "Adaption" process the developers will develop a solution working with users, test the solution then implement. This does not need to go through an intensive planning and requirements process. Hence when developing the solution, the methodology may not entirely be reflective of the SDLC methodology but rather hybrid which is embedded within the sociotechnical conceptual framework.

Previous researchers also conceptualized the co-existence of SDLC and Agile methodology (Vinekar et al., 2006; Bose, 2008; Cao et al., 2009). In particular, the paper by Aken (2008) proposes a software development methodology called CHUNK, which is a combination of both SDLC and Agile to consolidate the benefits of both methods. However, the limitation of the CHUNK method and other related attempts compared to the sociotechnical conceptual framework is that they do not talk to sociotechnical requirements (i.e. ETHICS). As such, the sociotechnical conceptual framework is relevant in guiding a sociotechnical system development process.

Figure 5: *CHUNCK Development Framework (Aken, 2008)*



Emerging themes and finding

This case demonstrated that the sociotechnical conceptual framework is flexible to accommodate both the SDLC and agile methodology for a sociotechnical system development. However it was noted that the 'External subsystem' was not applicable in this case as there was not requirement or input received from an external entity. This point was made by the developer who said *"we didn't have anything specific to the external subsystem, under the university they sign a code of conduct, contract and non-disclosure agreement which they should comply with and those are internal"* – System Developer (C). This view was further expressed by the project manager who said *"They did not really have anything external but they have to be cognizant of POPI requirements of protecting student information although the regulation was not yet enact"* – Project Manager (G).

Although the external subsystem may appear to be irrelevant as observed in the case, it does not mean it should be removed from the sociotechnical conceptual framework. This is mainly because there is evidence that although there were no requirements, there may be a need in future to accommodate any external system or compliance requirement. This view is derived from the point raised by the System sponsor who said *"If tomorrow the department of basic education were to make a change to the National Senior Certificate (NSC) and change it from 7 to 6 subjects, then they would have to change their validations on the system to cater for such, the Online application system needs to be a system that adapts to any internal or external changes that affect it"* – System Sponsor (A).

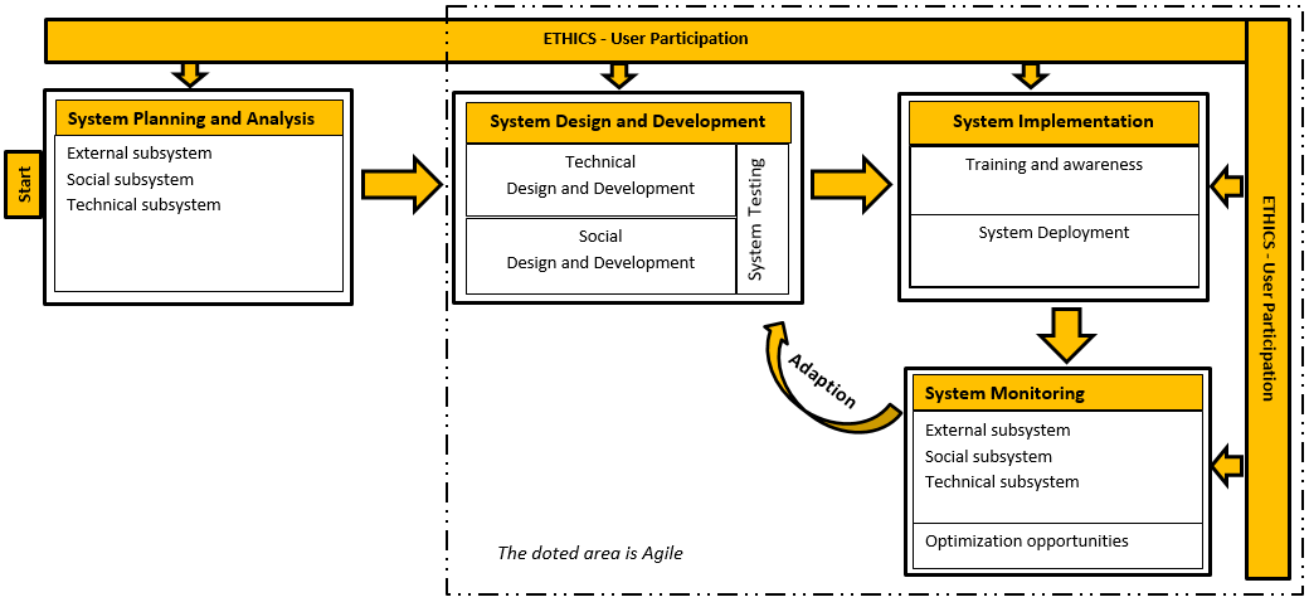
According to the sociotechnical conceptual framework as initially presented, user participation only touches 3 phases of the conceptual framework namely the Planning and Analyses phase, The System Design and Development phase and the System Implementation phase. In this case study it was noted that user participation is also imperative for the 'System Monitoring' phase of the conceptual framework. This was noted by the Enrolment center who *"sends a survey to applicants to on a quarterly basis to obtain their input and feedback"* – System Owner (A). The stakeholder feedback phase of the methodology, is intended to be executed multiple times throughout the system development life cycle (SDLC) – Aken 2008.

Revised sociotechnical conceptual framework

Based on the understanding discussed in the 'Emerging themes and finding' section above, the sociotechnical conceptual framework has been revised to include user participation for the 'System Monitoring' phase. Furthermore, a dotted square has been included on the conceptual framework to demonstrate which aspect or area of the framework talks to an agile approach with sociotechnical considerations.

So the current framework indicates that if a system is started from beginning it should follow a thorough system planning and analyses exercise to establish the various requirements and arrangements based on the sociotechnical subsystems. Thereafter the system development process will proceed to other phases as stipulated in the sociotechnical conceptual framework i.e. System Design and Development, System Implementation etc. However if there are new changes or enhancements they can follow the agile process as demonstrated by the dotted lines in the sociotechnical conceptual framework.

Figure 6: *Revised Sociotechnical Conceptual Framework*



7. Conclusion

7.1. Summary of Research

Although there is no development methodology that can guarantee the success of a software project implementation (Aken, 2008) the results of this study indicate that the sociotechnical conceptual framework is an applicable guide to develop a system which combines the merits of SDLC, ETHICS and Agile using a sociotechnical approach. In the conceptual framework ETHICS was in the core of facilitating the consideration for technical and social aspects in the development together with ensuring adequate participation from users and stakeholders. According to Stahl (2007) ETHICS can only be successful in a framework that is conducive to organizational democracy and participation, for which the proposed sociotechnical conceptual framework was strong on.

7.1.1. Summary of how research questions were addressed:

What sociotechnical issues did the university consider when developing their online application system?

Although sociotechnical considerations changed according to the various phases of the online application system, the university considered the technical efficiency of the system, inclusion of disadvantaged and disabled users and user friendliness.

How do sociotechnical issues during development influence the outcome of an online application system?

Although some sociotechnical issues were considered, every phase of the online application system had sociotechnical shortcoming which lead to the university to invest resources to address them.

Amongst others, these shortcoming included misalignment of technology, inadequate governance, limited resources, insufficient user participation and improper use of project management practices.

Notwithstanding the above view, it was noted that not all social and technical aspects can be predetermined as they are dynamic and they change in line with developments in society and technology. As such, it is imperative for one to deliberately consider all possible sociotechnical aspects of a system and involve users to ensure a holistic approach. Furthermore, one should have mechanisms to continuously monitor changing sociotechnical aspects that warrant a new development for enhancement (Adman and Warren, 2000; Davenport, 2008).

7.1.2. Summary of how research objectives were addressed:

Objective 1: To understand the role of sociotechnical issues in the development process of an online application system.

In the case study it was noted that sociotechnical issues were critical to be considered when developing a system to facilitate a positive likelihood. Although the involved team in the online application system considered sociotechnical aspects that could affect users, they did not pick up everything. As such from time to time, enhancements were required on the system to attend to any social or technical issues that arose and affected users.

Objective 2: To determine the applicability of the sociotechnical conceptual framework as a guide for understanding system development from a sociotechnical perspective.

The sociotechnical conceptual framework is relevant in guiding a sociotechnical approach to a system development because it is adaptive to accommodate both the SDLC and Agile methodology. However, in the initial sociotechnical conceptual framework provided (refer to APPENDIX B) it was not explicitly illustrated and stated like the revised sociotechnical conceptual framework as noted the Figure 3. For example, for agility if there is any optimization opportunities or new system requirements, through the “Adaption” process the developers will develop a solution working with users, test the solution then implement. This does not need to go through an intensive planning and requirements process

Objective 3: To identify and report any influence or implication of sociotechnical issues in the development of the online application system.

Upon examining the sociotechnical considerations and issues as discussed in section 6.1 and 6.2 respectfully, it was noted that sociotechnical issues can determine the success or failure of a system however it was also noted that not all social and technical aspects can be predetermined due to various dynamic. Sociotechnical issues can change in line with developments in society and technology. As such, it is imperative for one to deliberately consider all possible sociotechnical aspects of a system and involve users to ensure a holistic approach.

7.2. Research contribution

Institutions can use this sociotechnical conceptual framework as a guide to encourage a coherent consideration of both social and technical aspects when developing a system. Moreover, the research through the guidance of the sociotechnical conceptual framework sets an expectation that users should be involved in the various stages of the system development to ensure relevance and efficiency of the system.

Furthermore, the outcome of this research may also create awareness to academics, practitioners and organizations about the significance of using a sociotechnical approach to system development and some significant areas to consider during the development of an online application system. Notwithstanding the above contribution, the research gives a point of reference and guide on how universities can develop an online application system using a sociotechnical approach to manage user resistance and maximize the possibilities of system success.

7.4. Limitations of the study

The following limitations were noted in the study:

- When the study was conducted, the online application system was on phase 3 at the System Design and Development stage. As such, information of how sociotechnical issues played out for Phase 3 could not be obtained as those stages were still due to unfold.
- The study was based on the people that were involved in the online application system from the beginning. As such, key people that were there but left could not form part of the study, therefore limiting the information that could be obtained e.g. the developer for phase 1 resigned.
- Not much secondary information was obtained from the study particularly on phase 1 and 2 because processes of documentation and achieving were not formalized and project management practices were not entirely followed. As such the integrity of the assessment may could be compromised.
- The study was based on one system development case study in the University. So the findings may not be generalized to other universities or organisations.

7.5. Suggestions for future research

The sociotechnical conceptual framework gives a structural view of how a system can be developed using a sociotechnical approach. However it is not detailed on the factors or specification organisations should consider on every subsection of the sociotechnical conceptual framework. As such, the sociotechnical conceptual framework lacks the level of detail that will enable a practical development or implementation of a sociotechnical system. This observation was also made by Stahl (2007) who said one of the challenges in the future development of sociotechnical design will

be to spell out its ethical foundations in detail. He further added that only after that level of detail is achieved will we stand a chance to appreciate the full philosophical and reliability of a sociotechnical system design.

Therefore, future research should identify and list factors that should be considered for every subsection of the sociotechnical conceptual framework. For example, for the External subsystem under the 'Planning and Analyses' phase of the sociotechnical conceptual framework could include factors such as regulatory requirements, 3rd party system interdependencies etc. A list of these factors for every subsection of the sociotechnical conceptual framework will give a comprehensive guide for business or practitioners to following when developing a system using a sociotechnical approach. Given the dynamic changes in society and technology, the list may not always be reflective of all requirements however it should give users key consideration for a sociotechnical system development.

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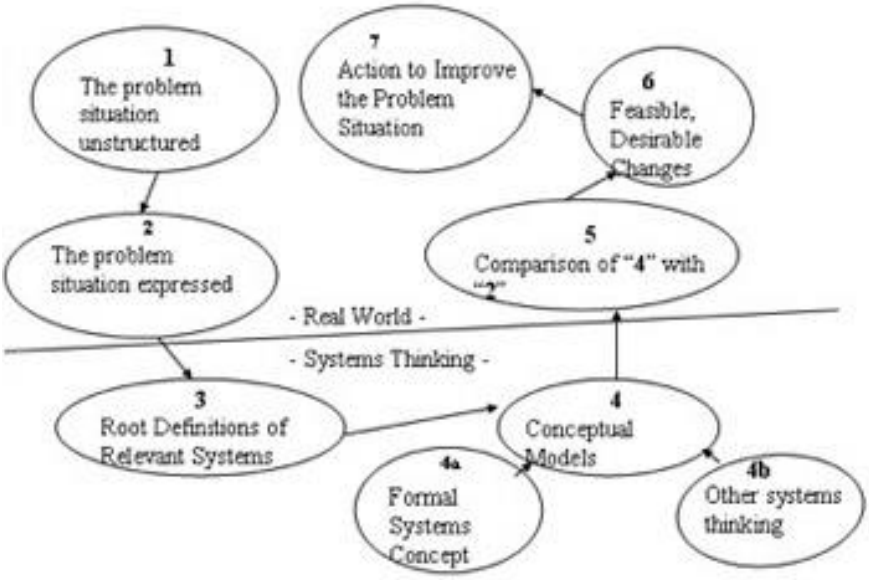
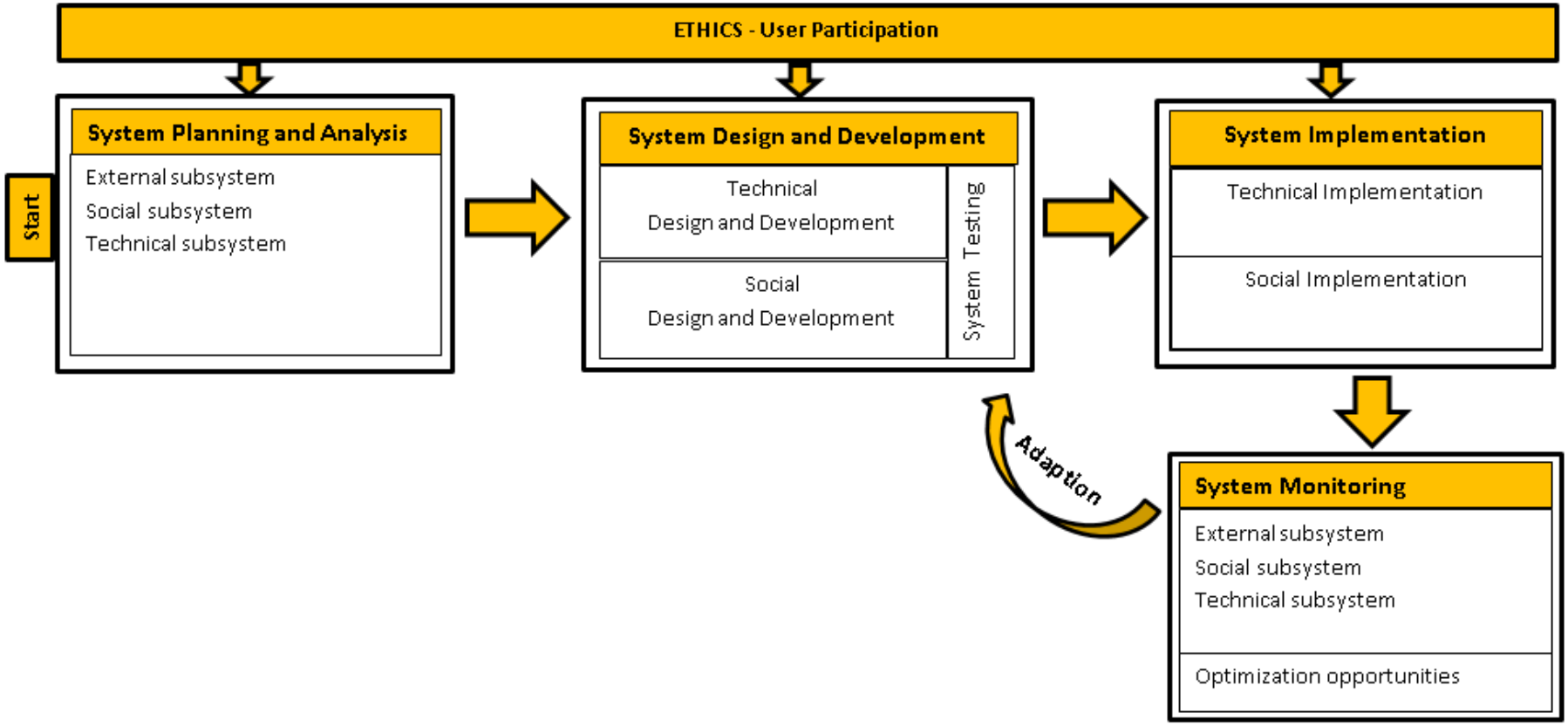
APPENDIX A - Soft System Methodology stages (Checkland, 1981)



APPENDIX B – Sociotechnical Conceptual Framework



APPENDIX C - Consistency matrix & Interview Questions

No.	Research questions	Sociotechnical Conceptual Framework Phase	Interview Question	Sociotechnical Conceptual Framework component
1	What sociotechnical issues did the university consider when developing their online application system?	System Planning and Analysis	1. What was the business problem that the online application system was going to address?	Social subsystem
			2. How were the users affected by system involved in the process of implementing the online application system i.e. where they represented or consulted for consensus?	Social subsystem
			3. Planning and analysis Do you think all stakeholders of the system were given an adequate chance to contribute in finalise the systems requirements and solution, if not why?	Social subsystem
			4. Was there any external issues outside the organizations that were factors in the planning of the Online application system i.e. regulation, competition, integration, etc.	External subsystem
			5. Do you think there was sufficient organizational support and stakeholder cooperation in relation to the development of the system?	Social subsystem
			6. Were there any internal organizations factors that were contributors to the planning and analysis of the online application system?	Social subsystem
			7. What were the key technological considerations for planning for the online application system?	Technical subsystem

			8. Do you think all system dependencies and other related technical considerations were sufficiently taken into account?	Technical subsystem
			9. What other factors do you think were key contributors in the planning and analysis of the online application system?	External, social and technical subsystem
2		System Design and Development	1. When developing the online application system what technological and social requirements were considered to be important?	Technical and social design and development
			2. How did you test the technical functionality of the online application system?	Technical design and development
			3. How did you test the social functionality of the online application system (i.e. user friendliness, User buy in etc.)?	Social design and development
			4. Can you please explain how users were involved in the requirements gathering and development of the online application system?	Social design and development
			5. Do you think the involvement of users in the development of the online application system was sufficient; if not, how do you think users should be involved.	Social design and development
			6. Where there any tests performed before deploying the system to production? And if so what were the outcomes.	System testing
3		System Implementation	1. Was there any training and awareness program done for the users of the system. And if so what was the feedback	Social Implementation
			2. What social or non-technical preparations were done prior to the deployment of the online application system?	Social Implementation

			3. Was there communication to inform users, operational managers or related stakeholders that may be impacted or distracted by the deployment of the application?	Social Implementation
			4. Haw the system performance and integration as expected, if not what were the issues	Technical Implementation
4	How do sociotechnical issues during development influence the outcome of an online application system?	System Monitoring & Adaption	1. What programs are in place to obtain user feedback and concerns on the online application system? And how often is such feedback obtained.	Social and technical subsystem
			2. How is the technical performance and capacity of the system monitored and managed	Technical subsystem
			3. How would the team detect changes from external forces that warrants changes to the system i.e. regulation changes and integration with external entity	External subsystem
			4. What in your view influenced the success or failure of the project?	Social and technical subsystem
			5. How are new opportunities identified to increase user satisfaction	Optimisation opportunities

APPENDIX D - Sociotechnical Factors

Author and title of the paper	**Purpose of study**	**Identified Factors**	**Findings**
KNAPP (1955) An investigation into the organizational and technological factors that contribute to the successful implementation of case technology	This study examines the organizational and technological factors that contribute to the successful implementation of CASE (computer-aided software engineering) technology.	- Management Support and Commitment - Technology infrastructure - Training of technical staff and end users - Implementation Strategy	This study found that CASE implementation success relies on the interaction between management's understanding of information technology, the information systems development environment, and the complexity of application systems that are developed in an organization.
Fowler (2007) Are Information Systems' Success and Failure Factors Related? An Exploratory Study	The study looked at the relationships among the factors most influential in IS success and Failure.	- Top Management support - Effective project Management - Personnel knowledge and skills - Enlisting of external contractors - User acceptance	This study found that four of the six factors identified by the participants in their chosen system as being the most influential in the success of the system were directly related to the factors identified from the literature as being most associated with IS failure.
Nandhakumar (1996) Design for success?: critical success factors in executive information systems development	The study explores the theoretically-based explanation of the process by which the relationship between key success factors and the EIS development operated.	- Market conditions - Company policy - Hierarchy and relationship with executives - Technology innovation - Technical resource allocation - System security - Screen design conventions - Standards on reports and formats	This paper argues that a better understanding of the relationship between key success factors and the EIS development is required if success factors are to be of any guidance to the practitioners to develop effective information systems.

APPENDIX E - List of participants

Identified interviewees per their role	Participant Pseudonym	The phase the interviewee participated in	Role description
Student Enrolment Centre	Respondent A	Phase 1, 2 and 3	The main sponsor and owner of the online application system.
System Support	Respondent B	Phase 2 and 3	Provided system testing and support for the central student system. And participates in the system development process for data collection, meeting project requirements, dealing with system issue resolution.
System Development	Respondent C	Phase 2	They programed, deployed and enhanced the Online app to meet business requirements.
System Development	Respondent D	Phase 2	They programed, deployed and enhanced the Online app to meet business requirements.
Quality Assurance (QA)	Respondent E	Phase 2 and 3	To test the system before any deployment to production. This ensures that all integrations, functionality and related items are tested so business is not impacted.
Central student system Owner	Respondent F	Phase 1, 2 and 3	Manages all development and deployments on the central student system which includes the new online application system.
Project Manager	Respondent G	Phase 3	Managed the project of developing and implementing the new online app
Senior Project Manager	Respondent H	Phase 3	Coordinated project governance and provided oversight over the “5 big” projects of the University which included Online Apps

APPENDIX F - Table of Initial Codes

Sociotechnical Conceptual Framework Themes	**Sub level**	**Relation with data**	**CODES/SUB CODES**
End User Participation (EUP)	End User Participation (EUP)	Identify items or utterances that relates to participation and how it was carried out.	EUP
System Planning and Analysis (SPA)	External Subsystem 1 (ES1)	Identify items or utterances that relates to external subsystem i.e. regulations, vendors, compliance requirements etc.	ES1
	Social Subsystem 1 (SS1)	Identify items or utterances that relates to social subsystem i.e. user friendliness, system accessibility	SS1
	Technical Subsystem 1 (TS1)	Identify items or utterances that relates to the technical subsystem.	TS1
System Design and Development (SDD)	Technical Design and Development (ETDD)	Identify items or utterances that relates to the technical design and development subsystem.	ETDD
	Social Design and Development (ESDD)	Identify items or utterances that relates to the Social design and development subsystem.	ESDD
	System Testing (ST)	Identify items or utterances that relates to the System Testing subsystem.	ST
System Implementation (SI)	Technical System Implementation (ETSI)	Identify items or utterances that relates to the Technical system implementation subsystem.	ETSI
	Social System Implementation (ESSI)	Identify items or utterances that relates to the Social system implementation subsystem.	ESSI
System Monitoring (SM)	External Subsystem 2 (ES2)	Identify items or utterances that relates to the External subsystem for monitoring.	ES2
	Social Subsystem 2 (SS2)	Identify items or utterances that relates to the Social subsystem for monitoring.	SS2

	Technical Subsystem 2 (TS2)	Identify items or utterances that relates to the Technical subsystem for monitoring.	TS1
	Optimisation Opportunities (OO)	Identify items or utterances that relates to the External subsystem for monitoring.	OO
Adoption (Ad)	Adoption (AD)	Identify items or utterances that relates to the Adoption.	AD
Project Management (PM)	Project Management Issue (PMI)	Identify items or utterances that relates to the Project Management Issue.	PMI
	Project Management Methodology (PMMth)	Identify items or utterances that relates to the Project Management Methodology.	PMMth

APPENDIX G - Ethics Certificate and Protocol Number

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UNIVERSITY OF THE WITWATERSRAND JOHANNESBURG

CLEARANCE CERTIFICATE **PROTOCOL NUMBER: CINFO/1172**

PROJECT: **A SOCIOTECHNICAL APPROACH TO AN ONLINE REGISTRATION SYSTEM DEVELOPMENT: A UNIVERSITY CASE STUDY**

INVESTIGATOR: Eliya Sefoka

STUDENT NUMBER: **1522887**

SCHOOL: SEBS

DATE CONSIDERED: 14 March 2018

DECISION OF THE ETHICS COMMITTEE: Approved

NOTE

Unless otherwise specified this ethics clearance is valid for 1 year and may be renewed upon application.
Please remember to include the protocol number above to your participation letter.

DATE: 15/03/2018 **CHAIRPERSON: Jean-Marie Bancilhon**

cc: Supervisor:

Dr Emma Coleman

SCHOOL OF ECONOMIC & BUSINESS SCIENCES