# DEVELOPMENT OF AN INTEGRATED INFORMATION DELIVERY SYSTEM (IIDS) FOR THE FEDERAL UNIVERSITY OF TECHNOLOGY, YOLA

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**MARCH, 2010**

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M. Tech/OR/02/379

A PROJECT REPORT SUBMITTED TO THE DEPARTMENT OF STATISTICS AND OPERATIONS RESEARCH, SCHOOL OF PURE AND APPLIED SCIENCES, FEDERAL UNIVERSITY OF TECHNOLOGY, YOLA PARTIALLY FULFILLING THE REQUIREMENTS FOR THE AWARD OF THE MASTER OF TECHNOLOGY (M. TECH) DEGREE IN OPERATIONS RESEARCH.

SUPERVISOR: DR. ADAMU IDAMA

MARCH, 2010

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**Alvin Orisedavweji FORTETA**
**M. Tech/OR/O2/379**
**Dept. of Statistics & Operations Research**

**IS HEREBY APPROVED BY**

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|---|---|
| ..... | ..... |
| **DR. A. IDAMA** | **DATE** |
| *Research Supervisor* | |
| ..... | ..... |
| **DR. A. OKOLO** | **DATE** |
| *Head of Department* | |
| ..... | ..... |
| | **DATE** |
| *Dean, School of Post-Graduate Studies* | |
| ..... | ..... |
| | **DATE** |
| *External Examiner* | |

**CERTIFICATION**

This is to certify that this project titled *Development of an Integrated Information Delivery* System *(lIDS) for the Federal University of Technology, Yola, is* an original work carried out by

**Alvin Orisedavweji FORTETA**
**M. Tech/OR/O2/379**

under the supervision of Dr. Adamu IDAMA of the Department of Statistics and Operations Research, School of Pure and Applied Sciences, Federal University of Technology, Yola.

Except for brief excerpts duly acknowledged in the text, neither it nor any part of its contents has been presented as a research study or in partial fulfillment of the requirements for the award of any Diploma or Degree at any institution of Higher Learning.

**.....** **.....**
**Alvin Orisedavweji FORTETA** **Date**

**M. Tech/OR/O2/379**
*Researcher*

**.....** **.....**
**Dr. Adamu IDAMA** **Date**
*Research Supervisor*

## DEDICATION

This work is dedicated to all Information Systems Scientists.

**ACKNOWLEDGEMENTS**

I wish to acknowledge the ceaseless efforts of my supervisor, Dr. Adamu Idama, who ensured that though I came to this university a mere mathematician, I look forward to leaving a full fledged scientist. In many ways, he inspired and guided this study from the very onset. I wish to say a big thank you to him.

I also wish to acknowledge the efforts of my parents who made it a point of duty to ensure that I had a sound education. I thank you both very much.

Finally, I want to appreciate the efforts of friends and colleagues, too numerous to mention by name, who all stood by as a cloud of witnesses urging me on and bringing sound counsel whenever and wherever I needed it. May the God of the spirits of the prophets richly reward you all for your unfailing commitment. Thank you.

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**ABSTRACT**

This study is an Operations Research intervention effort aimed at redesigning the Information Delivery System of the Federal University of Technology, Yola. Various OR/IS techniques are utilised to arrive at a business process design which re-allocates available facilities and redesigns the information architecture for enhanced efficiency. It was discovered that while formal training is crucial to developing information literacy for the top management of FUTY, it is of limited significance in developing the same for academic staff who have relatively high levels of information literacy (averaging 66.8%). Though the study discovered that the computer literacy profile of staff and students was very low, it was nonetheless evaluated as being sufficient to support deployment of system wide information delivery systems after computer and internet appreciation training is made available. The study resulted in the development of a program, named Academic Locality Virtual Information Network (ALVIN), to drive a computer-based integrated information delivery system for certain key operational sectors in the University. This software system was developed using Visual Basic 6.0 for the front end of the main application and Microsoft Access 2003 for the backend. A seven-step implementation heuristic was proposed.

# CHAPTER ONE
# INTRODUCTION

## 1.1 BACKGROUND OF THE STUDY

The overbearing influence of information needs on our day to day activities has become so profound that in many ways, computer-based information systems (CBISs) have become absolutely indispensable to modern man. The twenty first century has become one populated by *geeks* and *gizmos,* and in which *silico sapiens* hold absolute sway (Forteta, 2005; p. 3). Our modern business, defence, education, and socio-political systems amongst others are only kept from attaining maximum entropy with their environments by sophisticated information systems which regulate the processing of the many millions of variables which are involved in keeping them in a homeostatic state. According to Keen (1991; p. 236), "business managers are moving from a tradition where they could avoid, delegate, or ignore decisions about information technology to one where they cannot create a marketing, product, international, organisational, or financial plan that does not involve such decisions."

Ray (2002 p. 48) has observed, and rightly so in many organizations, that one of the standard bugbears is the persistent belief that difficulty is a virtue in itself, even a sign of intelligence." Indeed, in many developing countries, much activity goes on resulting (pathetically) in only infinitesimal output. People work hard but are not necessarily as productive as one would expect. High inflation rates, low Gross Domestic Product (GDP), massive internal and external debt profiles, and a myriad other factors only serve to buttress the point. It appears that the inefficiency of systems, opacity of business operations, excessive waste, misallocation of resources, unwarranted multiplicity of processes, and generally poor planning have become the norm rather than the exception. How do decision

makers effectively manage the *messy* situation? Or perhaps it should rather be 'How can Operations Research (OR) practitioners effectively engineer the decision making process to dissolve the *mess*?'

In an attempt to proffer a solution to the old Latin riddle, *Quis custodies custodiet*[1]*,* this study would definitely, amongst other things, show plainly that OR is a fit candidate for the available job of '*Guard of the guardians*.'

## 1.2 PROBLEM SITUATIONS

### *The Situation in Developing Countries*

Mouchilli and Moukouop (2004) have observed that in most developing countries, only very few companies possess an *efficient information system*. Companies in these countries often favor the management of static information such as those related to accounting and salaries instead of managing the information flows of the entire business process. Decisions are often made based on the direct and visible impact of resources on the company's activities. In reality, however, the inherent problems are too complex for such superficial treatment.

In many developing nations, Gadiesh and Olivet (1997) have observed that "managers complain that they lack the decision-making power to do their jobs and that top leadership is unable to make decisions quickly." As evidenced in the system under study, these statements resonate with truth.

### *Brief History of FUTY*

In 1980, the Federal Government of Nigeria established seven universities in response to the widely acclaimed need to promote industrial development in the country. In order to facilitate the development of a corps of skilled, innovative, and technologically competent personnel who could effectively develop and nurture a technology-based economy for the nation, these universities were

mandated to focus on technology. They were located at Abeokuta, Akure, Bauchi, Makurdi, Minna, Owerri, and Yola.

FUTY was among these seven universities. It came into being in 1981 enrolling its first batch of students for the 1982/1983 academic session. Right from inception, the university set out for itself a goal that is captured in its motto "Technology for Development." In the last twenty years, the University, under several Vice Chancellors, has attempted to fulfill its mandate, being guided by the national manpower needs as enunciated through the Nigerian Universities Commission (NUC).

In 1997, after several determined attempts to enhance the efficiency of the educational sector, the Federal Government of Nigeria received the report from the Committee it set up to chart a course for the future of higher education in Nigeria. The report was the first major attempt to organize and structure the problem situations being experienced in the sector. An excerpt from this report reads:

> *The problems of education in Nigeria are legion. Their intensity, enormity and peculiarities might vary with the different sectors and institutions but, expectedly, these problems wear the common face of insufficient funding and low participation by various stakeholders and arise similarly from lack of political will and consistency of vision. The result of the myriad of problems is that the educational system has almost sunk to a state of emergency, thereby requiring... urgent and sustainable solutions* (FGN, 1997 *p. vi*).

In June 1984, however, the Federal Military Government (of Nigeria) had merged four of the new universities with other pre-existing ones. FUTY was affected by this development and was merged with the University of Maiduguri to become its *Modibbo Adama* College. In 1988, there was another policy

reversal by the new Military regime which resulted in a de-merger of the institutions.

Today, FUTY is a thriving *third generation university* with well over 15,000 students enrolled in the various programs it offers at Graduate, Undergraduate, Diploma, Certificate, and Pre-Degree levels (FUTY, 2003).

FUTY, founded in 1981 is one of the *'third generation' Universities* established in the years following 1980.

> *"From then, the problems of proliferation of Universities in Nigeria became exacerbated leading to more unwieldiness in [administrative] size of the institutions, thus hampering their cost-effectiveness in their provision of skilled manpower..."* (FGN 1997, *p. 49).*

The Committee further discovered that the absence of concerted and systematic planning which characterized the process of institutional development within the Nigerian educational system of the last quarter century is a pervasive feature of the entire wider system.

### *Academic and Administrative Structure of FUTY*

The academic structure of the University consists of Schools of study, organized Research Units, and relevant Teaching and Research Support Units. Each School has different program areas called *Departments* in which one or more specific degree programs are available. The Department is the basic unit of academic organization aimed at enhancing interaction between related disciplines in the University, while the Dean of School's office coordinates the activities of the various Departments. The overall affairs of the University are guided by Council in policy and financial matters while Senate determines all academic matters.

### *Systems Milieu*

The systems context of the proposed study becomes an essential factor in any Operations Research intervention study. The Federal University of Technology, Yola (FUTY) is a sub-system of the Nigerian educational system, which is itself a subset of the Nigerian industry.

The fallout of the structural and administrative decay in the Nigerian educational system is acutely felt in FUTY. On careful observation one perceives a profoundly sharp discrepancy between *what is* and *what should be*. The interaction of the various subsystems in FUTY and information transfer amongst them is greatly impeded by various *situations* which, of necessity, should be viewed as problematic. These elements resort to laborious and time-consuming means to facilitate this transfer of information amongst themselves. These problematic situations have led to a *degeneration* of the system, thus compromising speed, efficiency, effectiveness, security, and data integrity.

Champy (1997) has noted that *"to significantly improve the business, organizational boundaries must become more porous."* This indeed applies to the information delivery subsystem of FUTY. The problematic situations evidenced in this subsystem are characterized by *data partitioning* and *fairly impervious boundaries* amongst the elements of the *information delivery subsystem*. Thus the various elements are seen to work at cross purposes. Galbraith (1997, *p. 88)* asserts that "*...misalignment of strategy, structure and processes will cause activities to conflict, units to work at cross purposes and the organization to lose energy over many frictions*." This insightful note from Galbraith is vividly elucidated in FUTY, which is characterized by widespread *duplication of activities, information starvation* of various subsystems, inconsistencies in data banks, and indeed a totally *messy* situation. All this is

even more particularly so in the *information delivery subsystem*. Indeed, in a similar context, Desa and Christer (2001, *p. 249)* noted that *"the data situation…is believed not untypical of industry within a developing country where, if data is retained, it is patchy, incomplete, inaccessible, little used, and therefore of little value."*

## 1.3 DISCREPANCIES

Even a cursory glance at the problem situations described above brings to the fore the vivid discrepancies between *what is* and *what should be*. However, let us first consider some scenarios which typify the system under study before listing these discrepancies fully.

**SCENARIO 1: Student Registration**

*Musa Bamidele is a freshman at FUTY. He was admitted after having obtained sufficiently high grades during the University Matriculation Examinations (UME) and accepting an offer of provisional admission to study Operations Research. Right now, he is confronted with the arduous task of embarking upon and completing the registration process at FUTY. Despite the hassles involved, lectures proceed unrelentingly in his Department. He is not even sure of which classes to attend as he is yet to fully register his courses.*

*Arriving campus on Tuesday morning, he is immediately received by the unwelcome ineptitude of the Information Delivery System (IDS) which has failed to provide guidelines on the completion of the registration process. After being misled several times, he stumbles upon the Administrative block of the University where he is told to return the following day with his admission letter and Universities Matriculation Examinations' result slip. Wise counsel is given to him to be at the office early enough to avoid the queues. Early Wednesday morning, at 7:49 a.m., Musa is at the Administrative block. To his greatest*

*surprise, he finds himself at the rear end of an M/M/1 queue with* 24 *people already in the waiting line. The line steadily increases behind him as more of his colleagues come out from the various nooks and crannies of the University environs where they had dispersed in search of shelter the previous day. Some came from the Student Center lounge, some from classrooms and common rooms of the student halls of residence, and yet others from any one of several locations they were able to find. At exactly 9:04 a.m., some registration officials walked lazily into their offices and started preparing for the day's work. When it was* 9:42 *a.m., they finally began issuing registration forms to the freshmen. Before collecting the forms, the students had to fill their personal details into an old, dusty, tattered hardcover notebook. It became Musa's turn at exactly 10:54 a.m. From there, Musa went to the bursary office to pay his fees. There he met an M/G/6 queue this time with well over 350 people in the waiting line. Completely put off by the large crowd and scorching Yola heat, Musa balked, choosing to return the next day. After a long night in a filthy, mosquito-infested hall known as the Student Centre lounge, Musa was at the bursary office by* 6:57 *a.m. on Thursday. This time, he found himself a little closer to the front of the queue with only* 13 *people ahead of him. The university had made arrangements with some local commercial banks to receive the students' fees on the University premises. The bank staffs were more prompt in service delivery than the University officials. By* 8:36 *a.m., he had concluded payment formalities. Urged on by the University deadline for conclusion of registration, he hurried to the convocation square to see his Departmental course adviser to register his courses. As usual, he met a queue there and joined it. This time around, mayhem broke out as some unruly students tried to 'jump the queue.' 'Push came to shove' and a 'fight' broke out. It took the better part of an hour to*

*restore order to the vicinity and the registration process continued at* 9:43. *By* 2:21 *p.m., Musa had concluded his course registration and left the vicinity.*

*All was not yet over for Musa however. He still had to register with the University library and the medical center, make arrangements to "hustle" for accommodation, and secure his student identity card. On getting to the library, he was given a form to fill which had to be countersigned by his Head of Department (HOD). He hurriedly took the form to the Departmental office where he was asked to return for it the next day. Friday by* 8:28 *a.m., Musa returned for the form. He took it to the library and was told to come back after 10 days for his library cards…*

In all, Musa spent two hassle-filled weeks to complete the registration process, missing several classes in the process.

**SCENARIO 2: Student Registration**

*Ekaette Mfon is a freshman at FUTY. She visited the Joint Admissions and Matriculation Board (JAMB) website and discovered that she had been offered provisional admission to study Information Technology at FUTY. She quickly navigated to the FUTY homepage and electronically accepted the offer of admission. An automated response from the FUTY IDS was immediately posted to her mailbox. This she retrieved immediately and discovered an electronic copy of the University prospectus and a detailed registration guide. The JAMB information systems had already verified her credentials through a secure automated link with the relevant examining bodies. Ekaette went to the local branch of one of the designated receiving banks and paid her fees (she also had the option of paying online if she banked with any one of several banks which supported the technology or made use of an online credit card). She was*

*immediately issued a scratch card with an 18-digit personal identification number (PIN). She returned to the internet kiosk and once again accessed the FUTY website and navigated to the freshmen registration page. She completed her registration online and selected one of the hostel accommodation options still available. Immediately she concluded the registration process, an automated response was sent to her mailbox giving details of her registration status and hostel room number. On the resumption date, Ekaette arrived at school and went right to her designated hall of residence. Upon personal identification from the university student databases through the computer terminal in the hall office, she was immediately issued her student identity card, room key, and matriculation gown.*

> In all, Ekaette spent less than 90 minutes in relaxed settings to complete the registration process without missing a single class.

Scenario 1 may initially seem extreme while scenario 2 may appear unrealistic. The experience of scenario 1, however, is a painful reality to the teeming population of the system under study, whereas scenario 2 is attainable ***only after*** having developed an Integrated Information Delivery System (IIDS) as is proposed by this study. It is argued therefore that scenario 1 could be described as WHAT IS (the reality), while scenario 2 could be described as WHAT SHOULD BE (the desired state). Table 1 goes on to further elucidate the major discrepancies between *what is* and *what should be*.

TABLE 1: DISCREPANCIES BETWEEN WHAT IS AND WHAT SHOULD BE

| | WHAT IS | WHAT SHOULD BE |
|---|---|---|
| 1. | Chaotic and labor-intensive methods of data collection, storage, transformation, and retrieval. | System-wide automated data capture and storage systems providing instant secure transfer and access to data items and information. |
| 2. | *Agonizingly slow and tedious process* of service delivery for information related services. | *Enhanced service delivery speeds* through the use of instantly available data items and information. |
| 3. | *Inadequate deployment of IT* resulting in manual processing of data items. | Deployment of IT tools to automate various organizational processes. |
| 4. | *Unduly high cost* of telecommunication services. | *Reduced cost* of telecommunication services. |
| 5. | Poor data and information interchange between subsystems. | Fairly permeable subsystem boundaries permitting free data interchange amongst subsystems. |
| 6. | *Unduly large budgets* for the subsystem to cover cost of manpower and supplies. | *Trivial budgets* for the information service functions in the system. |
| 7. | *Inadequate access* to internet services. | *Adequate access* to internet services. |
| 8. | Rigid, paper-based, manual information systems the norm for a large proportion of data contained in the system. | Computer-based information systems to manage all data in the system. |
| 9. | Weak MIS unit unable to generate up-to-the-minute reports for Operational or Top Management and Council. | MIS unit which presents up-to-the-minute reports in a *timely manner*. |
| 10. | Weak information function unable to forecast future information needs of Management and Council. | Enhanced information function able to forecast information needs through the use of information technology tools. |
| 11. | Chaotic, paper-based system of storage for research findings and scientific information. | On-line storage system for all scientific research works and related information in the system. |

## 1.4 PROBABLE REASONS FOR THE SITUATIONS

The problem situations in the IDS of FUTY can be properly described as a *mess*. *Messes* usually do not have a unique causative factor. They are rather dynamic situations that consist of complex systems of changing problems that interact with each other (Ackoff, 1979 a). Ackoff further asserts that the behavior of a

*mess* depends more on how the solutions to its parts *interact* than on how they *act* independently of each other. Based on conjectures proffered by this researcher, some of the more prominent interacting and causative factors are as follows:

1. Inadequate financing of the system leading to degeneration of its constituent elements.
2. Poor requisite skills on the part of the administrators of the information subsystem.
3. Desire of certain individuals within the system to perpetuate the *mess* as a cover for their nefarious activities.
4. Carelessness and indifference of the administrators of the system.
5. Weak or non-existent professional advice to management.
6. Inadequate oversight by supervising officers of the subsystem.
7. Information systems illiteracy of top management and administrative heads.
8. Computer illiteracy of top management and administrative heads.
9. Use of inadequate study designs in attempts to dissolve the *mess*.
10. Outright rejection of OR as a viable tool for managing the *mess*.

## 1.5 PREVIOUS ATTEMPTS AT SOLUTIONS

Over the years, various attempts at solving/resolving/dissolving the *messy* situation have been attempted with varying degrees of success. Some of these attempts include hiring of more clerical staff, retraining of administrators for the subsystem, establishing a Management *(Mis)*Information System, setting up an ICT committee, as well as implementation of several *small-scale intervention study* recommendations. Unfortunately, however, the *mess* continues to proliferate unabated. It is however pertinent to note that at no point in time was

a system-wide intervention attempt undertaken. This is, in the view of this researcher, an appallingly unfortunate situation considering the number of OR-trained scientists and wealth of research resources available for use by the decision makers.

## 1.6 JUSTIFICATION

The Porter-Miller information intensity matrix (Robson, 1997) shows education as an industry with high information product content as well as high value chain information content alongside defence and scientific research. This brings to the fore the grave need for the implementation of computer-based information systems (CBISs) in academic institutions. Properly implemented, CBISs can be helpful in freeing up of personnel to enable them devote their best time to other more productive labours as well as generating hyper-productivity in their information-related tasks.

Dissolving the information delivery system (IDS)-related *mess* in FUTY might obviously not only be a timely OR intervention, but a crucial one. Firstly, it would vividly portray to University Management the usefulness of OR in the information delivery function of FUTY. It has been the personal experience of this researcher to be confronted by a top administrative staff of FUTY who strongly believes that OR has no relevance in the information delivery function of an organization. This study, if successful, might go a long way to help obliterate the misconceived *vermessens*[2] about OR as well as some of the biases held against many OR practitioners particularly in information systems development. This is in consonance with the observation that the OR practitioner sees his or her task as including breaking new ground and *changing* client *perceptions* of issues, their importance, and the relevance of OR to their resolution. The OR

worker is in this regard, a change agent, and the changes in question are often *deep-seated values or practices* (ORS, 1986).

Secondly, the findings of this study are of crucial significance to the continued existence of the University in a dynamic steady state. As a socio-technical (open) system, it can maintain a dynamic steady state only by continually importing material, energy, and information, transforming them, and redistributing resources to the environment (Idama, 2003 a). The information delivery subsystem may be seen as fundamental to this entire process. If the *mess* in the subsystem continues to proliferate, the system may become unable to offset the forces of entropy *in-articulo mortis*[3] and may thus eventually attain maximum entropy with its environment.

Thirdly, the University has a similar organizational structure and operational procedures with other Universities all over Nigeria (Mustapha, 2003). A successful business process reengineering effort in FUTY would go a long way in aiding the improvement of the performance of academics in Nigerian universities.

Fourthly, since the problem situation is characteristic of industries in developing countries (Desa & Christer, 2001), and the system structure is synchronous to that of other Nigerian universities (Mustapha, 2003), the findings of this study may be of profound interest to other industries in the developing world; notably, academic institutions, government agencies, the military, the police, State-owned enterprises, and indeed, all other industrial concerns. These would, one and all, find this study of crucial significance in their quest for efficiency in this *digital age*.

Finally, on whether or not this study qualifies as an OR study, Laudon and Laudon (1998) argued that whatever their scope and objectives, new information systems are an outgrowth of a process of organizational problem solving. They also argued that information systems development demands interdisciplinary activity (Laudon & Laudon, 1998; p.13-14). If indeed OR is all about an interdisciplinary approach to organizational problem solving, then this study must be seen to qualify as an OR research.

## 1.7 AIM AND OBJECTIVES

The aim of this study is to develop application software to drive an Integrated Information Delivery System (IIDS) for the Federal University of Technology, Yola. This software should be efficient and scalable enough to be deployed on all computer workstations in the university, and flexible enough to be adapted to the varying needs of the university and its perceived future requirements.

### *Ultimate Objectives*

Idama (2003, b) has defined ultimate objectives as the expected and hopeful emphasized contributions which the research would make towards solving the problem under investigation. Thus, the ultimate objectives of this research are to:

1. *Dissolve the mess* in the IDS of FUTY.
2. Create a computer-based Integrated Information Delivery Subsystem (lIDS) for FUTY.
3. Identify and proffer solutions to some of the factors responsible for the averseness to the use of scientific techniques in organizational problem solving by decision makers in Nigerian universities.

***Immediate Objectives***

Idama (2003, b) has defined immediate objectives as the promise the researcher gives that certain activities would take place and that specific variables will be examined. The immediate objectives therefore of this research are to:

1. Carry out surveys on academic, operational, and administrative staff of FUTY, as well as students, to assess: computer literacy, information systems literacy, and attitudes towards the proposed IIDS and related Academic Locality Virtual Information Network (ALVIN).
2. Carry out surveys on management staff and operational heads to assess the information requirements of the various units.
3. Create the framework for the development and deployment of an Academic Locality Virtual Information Network (ALVIN) for FUTY.

In the pursuit of these objectives, it is the desire of this researcher to enlist the services of 5 – 10 research assistants. These assistants would be engaged in administering the data capture forms, data collection and collation, design of computer system networks, architectural design, and serving as a repertoire of ideas representative of their various fields. The assistants will be drawn from among the 300 - 500 level students of Operations Research, Computer Science, Electrical and Electronics Engineering, Information and Communication Technology, Management Science, Urban and Regional Planning, and Architecture departments of FUTY.

## 1.8 RESEARCH QUESTION

Central to this research is the question:

*How do the decision makers effectively <u>dissolve</u> the problem situations in the IDS of FUTY?*

## 1.9 POSSIBLE ANSWER

It is the educated opinion of this researcher that a system-wide OR intervention project utilizing the vast array of scientific techniques and Information Technology (IT) tools available to the OR practitioner could adequately dissolve the *mess* **if** *fully* implemented.

## 1.10 RESEARCH PROBLEMS

In this research, the decision makers are faced with the following problems which the study should aid in solving:

i. How does FUTY provide an estimated 5,625,000 man hours of internet access to its student body?

ii. How does FUTY provide unrestricted internet access to its academic staff body?

iii. How does FUTY develop, implement, and sustain an integrated information systems policy?

iv. How does FUTY finance the options i – iv above?

## 1.11 *ASSUMPTIONS*

In an attempt to effectively address the problem situations already identified in this study, some *apriority* expectations exist. These, are anticipated, though surveys may show them for what they are. These expectations are:

1. Top Management staff have similar perception with each other of the existing information delivery system.
2. The level of computer literacy of FUTY academic staff is adequate to warrant the deployment of an integrated computer-based information system.
3. The level of computer literacy of FUTY administrative staff is adequate to warrant the deployment of a university-wide computer-based information system (CBIS).

4. The level of computer literacy of FUTY students is adequate to warrant deployment of automated online information collation and dissemination systems.

## 1.12 WELTANSCHAUUNG[4]

The world-view upon which this study is based may best be described as an intricate, omnivoyant combination of conceptualizations. These are certain assumptions made in order to facilitate this study. It should be noted that this is a research study in partial fulfillment of the requirements for the award of an academic qualification and not an intervention requested by a paying client. The following statements encapsulate the *weltanschauung* of this study:

1. It is possible to enhance service delivery and organizational efficiency in Nigerian universities by effective deployment of well designed computer-based information systems.
2. Nigerian universities have adequate resources available to them to deploy CBISs in an effective manner.
3. Operations Research (OR) is a competent discipline to guide the development and deployment of system-wide CBISs.
4. It is totally unnecessary to "re-invent the wheel." The *client* should effectively make use of whatever resources are presently available, rather than seeking out excessively elaborate and costly alternatives.

## 1.13 DELIMITATIONS

It must be kept in mind that this study is an attempt to simulate a real life OR intervention project. This study is carried out in the real world subject to constraints which are at once both many and multifaceted. As such, it becomes imperative to delimit this study in order to keep within the constraints of available time, finance, resource availability, and indeed a host of others. This study is therefore delimited to the following areas:

1. The Sangere (main) campus of the Federal University of Technology, Yola.
2. The following functional aspects of the information delivery system of FUTY; the university library, staff personal records, staff medical records, student academic records, student personal records, student medical records, student hostel accommodation, student registration, and security.

## 1.14 OPERATIONAL DEFINITION OF TERMS

1. Degeneration: *the process of becoming physically or morally worse.*
2. Data partitioning: *the division of information into parts amongst the various units of the system, or the state of information being divided into parts.*
3. Fairly impervious boundaries: *subsystem boundaries that impede the free flow of information from one subsystem to another.*
4. System: *The Federal University of Technology, Yola.*
5. Wider system: *The Nigerian educational system.*
6. Subsystem: *Any of the units of the Federal University of Technology, Yola.*
7. Information: *Various types of processed data stored in the system and transferred amongst its subsystems to be used for decision-making.*

8. Information delivery subsystem: *The various humans and materials that are directly involved in the process of information collection, storage, collation, retrieval and transfer of information in FUTY.*
9. Duplication *of* activities: *The process of primary data-collection of information already contained in the system.*
10. Information starvation: *Privation in certain subsystems of information contained in the system which is important for the maintenance of dynamic equilibrium in that subsystem.*
11. *Messy* situation: *Proliferation of problems in an interrelated and highly complicated manner so as to make them difficult to clearly delineate and define.*
12. Inadequate financing: *Inability of the system to obtain adequate financial credit to undertake its activities as and when necessary.*
13. Poor requisite skills: *Inability of the human elements to adequately manage the complexity of the subsystem they are required to administer.*
14. Nefarious activities: *Behavior which predisposes the system to advance towards a state of maximum entropy.*
15. Carelessness and indifference: *Lack of interest, care, or concern in maintaining the system in a homeostatic state.*
16. Inadequate study designs: *Scientific methods which may be useful in other situations, but are not suited to the particular problem situation under consideration.*
17. Small-scale intervention studies: Researches by undergraduate and graduate students *of* FUTY which are not system-wide in scope.

18. Dissolve the problem situation: Creation *of* an *Idealized Design* for the system which effectively causes the problem situation(s) to cease to exist.

19. Third Generation University: Any of the Nigerian Universities created as from the year 1980.

20. Inadequate deployment of IT: Misallocation of information technology in such a manner as not to benefit from its deployment as an effective information system.

21. Management *(Mis)*Information System: In this study, this statement refers to the Management Information System of FUTY in its present state of impeded efficiency.

## 1.15 OPERATIONAL DEFINITION OF VARIABLES

1. Agonizingly slow and tedious process: Anything more than waiting time of five minutes for initiation of the service delivery process.

2. Enhanced service delivery: Service delivery process initiated within waiting time of five minutes.

3. Unduly high cost: Existing cost.

4. Reduced cost: Less than or equal to 30% of existing cost.

5. Unduly large budgets: Existing budget.

6. Trivial budgets: Less than or equal to 30% of existing budget, less initial setting up expenses.

7. Inadequate access: Present level of access.

8. Adequate access: Unrestricted access for academic and administrative staff, and 30 hours per session for students.

9. Timely manner: Within waiting time of ten minutes from when requested or due.

## 1.16 CONNECTIVE SUMMARY

This preliminary chapter has taken a *bird's eye view* of the problem situations in context of the wider systems in hierarchy and has given a general thrust of the purpose, relevance and significance of a study of this nature. It has looked at the weltanschauung behind a study of this nature and has adequately defined relevant terms and indicated where related information can be located elsewhere in the body of this research report. The next chapter provides an overview of a choice collection of studies, write-ups and reports with scientific information of significant interest to this study.

# CHAPTER TWO
# REVIEW OF RELATED LITERATURE

## 2.1 INTRODUCTION

The literature on integrated information systems development is extremely extensive. It is a Herculean task to review even a fraction of the available literature within a single volume. However, in this study, we shall examine some of the available literature as it relates to the business process and behavioural aspects of information systems development as well as take a brief overview of the technological developments which make the world of information systems *go round*.

Traditional science, such as mathematics, chemistry, or physics, is one-dimensional in nature. Scientific studies have passed the one-dimensional science into a two-dimensional science period. The two-dimensional science is characterised by a cross-domain study. That is, it focuses on the relational rather than individual aspects of isolated domains, and its integration with the traditional disciplines of science. This research continues the vein of cybernetics, which is based on the recognition that information-related problems can only be meaningfully and beneficially studied, at least to some extent, independently of any specific context (Klir, 1985). As such, this study requires the input of several disciplines extracted from various one-dimensional fields of study such as computer science, organisational behaviour, psychology, network theory, queuing theory, optimisation, computer simulation, etc.

## 2.2 BUSINESS PROCESSES

The need for computerised mechanisms for decision support comes from well-known limits of human knowledge processing. Studies suggest that a person's capacity for processing the contents of his immediate field of awareness is

limited to manipulating up to about seven pieces of knowledge at any one time. The stress, error, and oversights that can result from being overloaded with knowledge can be just as detrimental as not having enough knowledge (Holsapple & Whiston, 1996; p. 1).

Gadiesh and Olivet (1997, p. 59) have affirmed that in their experience with systems development efforts in business process restructurings, it is often best to start with a diagnosis of how decisions are currently being made. It is foolhardy to approach a problem situation without such knowledge.

Somerville and Mroz (1997, p.75) noted that most change efforts fail because they are too costly, too risky, and too slow. The organisation, they say, usually thwarts progress.

Change is intrinsically unnerving to people at all levels, even to those who stand to benefit (Gadiesh & Olivet, 1997; p. 55). Thus in any business process redesign, the organisational aspects of the study must not be ignored.

According to Champy (1997, p.13), the larger the scale of a change program, the more likely it is to succeed. If the change program is large and it has the support of top management, the organisation is thus compelled to confront *all* that is required to manage the change.

Most organisational changes are made today in the name of improved business performance. However, while driving towards this result, it is imperative to keep in mind that ultimately, we strive to create a company that is agile, that can sustain multiple changes, and that is a good place in which to work. It is unrealistic and unreasonable to put in place an organisation that would not be

able to respond with agility five years from now when the next wave of industrial change would have arrived. Nimbleness and agility should be the principal design criteria (Champy, 1997; p. 16).

Systems redesign efforts often fail to realise that information technology is no better than the skills and competencies of the knowledge and information workers who would use it. Ultimately, the impact of computer-based information systems is no greater than the intelligence of the human elements it contains (Laudon & Laudon, 1998; p. 74).

Mouchilli and Moukouop (2004) have observed that in most developing countries, only very few organisations possess an *efficient information system.* Companies in these countries often favour the management of static information such as those related to accounting and salaries instead of managing the information flows of the entire business process. Decisions are often made based on the direct and visible impact of resources on the company's activities. In reality, however, the problems inherent in the very fabric of organisations are far too complex for such superficial treatment. The majority of information systems groups in developing countries, Nigeria in particular, act as mere repositories of data items, often in an uncoordinated manner. Indeed, in a similar vein, Desa and Christer (2001, *p. 249)* noted that "*the data situation…is believed not untypical of industry within a developing country where, if data is retained, it is patchy, incomplete, inaccessible, little used, and therefore of little value.*"

Kant (1790) seems to have foreseen these situations when he commented aptly that "None of these systems does what it professes to do." This is however in decidedly sharp contrast to the more recent observations of Molloy and Schwenk

(1995) who discovered (albeit only in developed nations) that information technology has had beneficial effects upon strategic decision making primarily by enabling faster and more accurate analysis.

In this study, the effort is an attempt at transforming the entire business process of the information processing subsystem of the University from a manual undertaking to a computer-based one. To achieve this, it becomes important to ensure that the organisational micro-culture of the University does not destroy the possible success of the intervention effort.

## 2.3 HISTORICAL DEVELOPMENT OF INFORMATION SYSTEMS

Until the 1960s, the role of information systems was simple: transaction processing, record keeping, accounting, and other forms of electronic data processing applications. Then, another role was added as the concept of Management Information Systems (MIS) was conceived.

By the 1970s, it was evident that the pre-specified information products produced by such MISs were not adequately meeting any of the decision making needs of management. Hence, the concept of Decision Support Systems (DSS) was born.

In the 1980s, several new roles for information systems appeared. First, the rapid development of microcomputer processing power, application software packages, and telecommunications networks gave birth to the phenomenon of end user computing. Later, it became evident that most top level corporate executives did not directly use either the reports of MISs or the analytical modeling capabilities of DSSs, so the concept of Executive Information Systems (EIS) was developed.

Afterwards, breakthroughs were made in the development and application of Artificial Intelligence (AI) techniques to business information systems. Expert Systems (ES) and other knowledge-based systems forged a new role for information systems.

Finally, an important new role for information systems appeared in the 1980s and continues into the 1990s and beyond. This is the concept of a strategic role for information systems, sometimes called Strategic Information Systems (SIS). Information systems are now no longer just an information utility, but they must become a producer of information-based products and services that earn profits for the firm and also gives it a competitive advantage in the marketplace.

All these changes have increased the importance of the information systems function to the success of a firm. However, they also present new challenges to managers and end users to effectively capitalize on the potential benefits of information technology. (O' Brian, 1995; Forteta, 2004a; Gates, 1995; Green1994 – 2002; Encarta, 2002)

## 2.4 STATE OF THE ART IN COMPUTER NETWORKING

Many organisations today are linking mainframes, minicomputers, PCs, and smaller networks into company-wide networks or using the internet to link their networks to those of other organisations. This trend, known as *enterprise networking*, has both opened up vast possibilities and created new management problems. In enterprise networking, the components of the information architecture are arranged so as to place more of the organisation's computing power on the desktop and to create networks that link the various functions spread throughout an enterprise. In this model, the data and processing power

are distributed into the enterprise rather than being centrally controlled (Laudon & Laudon, 1998; Encarta, 2002).

Schatt (1992, p. 1) has identified the current benefits of networking computers together as opposed to the use of separate PCs as

1. More efficient use of hardware and software resources.
2. Ability to share key information easily.
3. Improved information management.
4. Improved security.

He further observed that networks force all users to follow the same information handling rules, thereby making information more readily accessible to the entire organization. Also, networks are known to offer an organization greater security than do stand-alone computers as users are usually required to use passwords to log onto the network and network software enables the network manager to audit users' activities (Schatt, 1992, Pp. 5 – 6).

The Large Hadron Collider Computing Grid (LCG) depicts the state of the art in computer networking technology. The grid now includes more than a hundred sites in 31 countries, making it the world's largest international scientific grid.

The sites participating in the LCG project are primarily universities and research laboratories. They contribute more than 10, 000 central processor units and a total of nearly 10 million gigabytes (10 petabytes) of storage capacity on disc and tape. The grid network is designed to support the Large Hadron Collider (currently being built at CERN near Geneva, Switzerland) due to become operational in the year 2007. When it does become operational, it is expected to produce petabytes (millions of gigabytes) of data which will need to be analyzed.

To achieve this grid networking feat, special middleware to allow seamless operations across multiple institutional domains is utilized. This is so that end users of the grid would perceive it as a single resource. Underlying the middleware is the basic infrastructure of the grid, which consists of extremely high speed networks, clusters of hundreds of computers at the participating sites, as well as banks of disc servers and tape silos for the data storage, also distributed across the globe (SCW, 2005 p. 7).

Indeed, such a setting, grid networking, enables organizations to achieve supercomputing processing power by linking ordinary personal computers using specialized middleware and network connections. The benefits of such a networking environment are yet to be reaped in most developing countries. Further on in this work, the potentials for FUTY of such a networked system would be elucidated.

## 2.5 STATE OF THE ART IN STORAGE SYSTEMS

New storage technology has been a theme of much discussion in IT circles in recent years. Development trends have progressed from the use of punched cards to magnetic tape to floppy discs and on to optical disc storage. The recent development of various types of USB storage devices has also been a welcome trend. Small, portable, and data efficient systems seem to be the order of the IT day. More recently, however, there has emerged the concept of network storage systems which microchip giant Intel appears to be spearheading (Forteta, 2004 b).

The rapid growth of e-mail and e-commerce combined to produce a dramatic increase in data moving across the public internet and enterprise IP networks.

This increase in data traffic has driven the evolution of data storage systems outside the traditional direct attached storage (DAS) model, developing systems embedded into the network itself. As a result, the industry is seeing the emergence of storage area networks (SANs) and network-attached storage (NAS) as popular systems. Indeed, important storage transitions are now underway, enabled by the emergence of complimentary networking and input/output (I/O) technologies. These trends include:

- The transition to Ethernet and Internet Small Scale Computer System Interface (iSCSI) technology for internet protocol (IP) based storage.
- The emergence of serial ATA (S-ATA) as a disc interconnect.
- The adoption of infiniband architecture as clustered system interconnects.
- The creation of a new serial bus architecture, PCI-Express as a general I/O interconnect capable of scaling to 10Gbps and beyond.

An emerging Ethernet-based technology known as iSCSI provides high speed, low cost, long distance storage solutions for web sites, service providers, enterprises, and other organizations. Traditional SCSI commands and data transfers are encapsulated in TCP/IP packets. The iSCSI standard makes it possible to build highly interoperable, low-cost IP-based SANs.

Intel has successfully completed development of a wide range of standards-based 10 Gigabit components and subsystems, supporting both 10-Gigabit Ethernet and Synchronous Optical NETwork/Synchronous Digital Hierarchy (SONET/SDH). Intel 10-Gigabit Ethernet products include switching silicon, optical modules, component silicon, MAC devices, adapters, SERDES

transceivers, Ethernet storage host bus adapters (HBAs), and Ethernet storage component silicon, all compatible with existing environments (Intel, 2004).

## 2.6 CONNECTIVE SUMMARY

It has been noted in this chapter that though CBISs are dependent on IT, they are designed, operated, and used by people in a variety of organizational settings. Thus the success of an information system should be calibrated both by its efficiency in terms of minimizing resource use as well as its effectiveness in supporting and meeting the goals of end users. In light of this, this chapter has examined related literature on both the technological and organizational aspects of the development and deployment of information systems.

It is imperative to mention at this stage that the literature examined thus far in this treatise does not exhaust the available literature on information systems development. It is nonetheless considered sufficient to provide a context for the research contained herein.

# CHAPTER THREE
# METHODOLOGY

## 3.1 INTRODUCTION

The concept of methodology in OR practice has generated widespread discussion in academic and practitioner circles alike (Ackoff, 1979, a, b; Beer, 1966, etc.). In the development of information systems, various approaches have also been postulated, developed and refined (see Robson, 1997; Morris & Brandon, 1989; Holsapple & Whiston, 1996; O' Brian, 1995; Laudon & Laudon, 1998; and others). Indeed, the question of methodology in CBIS development has a rich repertoire of historical precedent.

## 3.2 SYSTEM DESIGN METHODOLOGY

There are many and multifarious ways of developing integrated information systems for an organisation. However, due to the peculiarities of the system under study, the inherent constraints, and other intrinsic factors, this research approaches the development using an eclectic blend of various methodologies. This researcher has chosen not to be limited by any specific design method, but to apply whatever techniques are required to achieve the stated objectives of this study. This work draws upon the richness of the various OR and Systems methodologies complementing one another and making up for the perceived inadequacies in each other. Prototyping is however chosen as the preferred programming approach.

Nevertheless, Systems thinking forms the theoretical framework which under girds this study, with the Systems Development Life Cycle (SDLC) methodology and Relational Systems Development (RSD) forming the framework for the CBIS development. Other theories and methodologies only serve to provide more structured techniques where this researcher feels they are required.

Laudon and Laudon (1998; p. 430) have observed that the Systems Life Cycle methodology is the oldest method for building systems and is still used today for complex medium or large projects. Also, the RSD is a problem-solving approach to developing automated information systems which has distinctive advantages over many other methodologies. This is because it is a unified tool which provides both a development technique and project control procedures. Even though the methodology was specifically designed for on-line development, it is the most flexible of the methodologies (Morris & Brandon, 1989; p. 1). There is nothing at all sacrosanct about the RSD methodology they assert. Everything can be seen as amenable to modification. Hence, in this study, certain modifications to the methodology were made in order to facilitate ease and speed of development.

Vasko *et al* (2002) have developed a model for efficient development of optimal minimum spanning tree networks by combining the shortest path and minimum spanning tree problems. They hence developed the solution model to the cable trench problem (CTP). This method of developing an optimal network is applied in this study when developing the theoretical configuration for the network hardware infrastructure of the Academic Locality Virtual Information Network (ALVIN).

## 3.3 STUDY POPULATIONS

In this study, the population for the surveys comprises the following:

1. The top management of FUTY, consisting of seven (07) persons in the following official capacities:
    a. *Vice Chancellor*

b. *Deputy Vice Chancellor (Administration)*

c. *Deputy Vice Chancellor (Academic)*

d. *Registrar*

e. *Bursar*

f. *Director of Works*

g. *University Chief Librarian*

2. The entire academic staff of FUTY: As at the time of carrying out the relevant surveys, the numerical strength of the academic staff of FUTY was three hundred and ninety three (393). This is as obtained from payroll data in the University's Bursary unit.
3. The entire undergraduate student body of FUTY. This was estimated at fifteen thousand (FUTY, 2003).

It should, of course, be recalled that all these population strata have been delimited to the Sangere campus of FUTY (see section 1.11, p.18).

## 3.4 SAMPLE SPACES AND SAMPLING PROCEDURE

In picking a representative sample, this researcher has, for the various population strata identified in section 3.3 above, chosen as follows:

TABLE 2: POPULATIONS, SAMPLES, AND SAMPLING PROCEDURES

| S. No. | Population | Sample | Sampling Procedure |
|---|---|---|---|
| 1. | Top Management | 100% of population | Deterministic |
| 2. | FUTY Academic staff (393) | 10% of population (40) | Stratified random sampling |
| 3. | Students | 200 individuals | Multi-stage random sampling |
| 4. | Computer-based information processing systems | 100% of population | Deterministic |

## 3.5 METHODS OF DATA COLLECTION

The procedures employed in obtaining data for analysis in this research are as shown in Table 3.

TABLE 3: POPULATION, DATA COLLECTION PROCEDURE AND PURPOSE OF DATA COLLECTED

| S. No. | Population | Data collection procedure | Purpose |
|---|---|---|---|
| 1. | Top Management | Questionnaire | Determine data and information requirements and IS literacy profile of Top Management. |
| 2. | FUTY Academic staff | Questionnaire | Determine IS and computer literacy profile of FUTY academic staff. |
| 3. | Students | Questionnaire | Determine IS and computer literacy profile and challenges to IS/computer literacy of FUTY students. |
| 4. | Information processing systems | Analytical examination | Comparative evaluation of existing information processing tools, with a view to determine areas of potential development. |

## 3.6 METHODS OF DATA ANALYSIS

Descriptive statistics shall be used to bring out the various factors of interest in the study populations. Correlation coefficients shall be obtained using the Pearson product moment correlation. The formula (Wikipedia, 2009 a) is:

$$r = \frac{\sum (x - \bar{x})(y - \bar{y})}{\sqrt{\sum (x - \bar{x})^2 \sum (y - \bar{y})^2}}$$

Also, Bartlett's test for equality of variances is used to assess if there indeed exists a significant difference between the variances of responses of top management's rating of the existing information delivery system. The test also applied to academic staff to determine if there is indeed a significant difference in their computer literacy profiles. In addition to this, the Bartlett's test is used to

ascertain whether or not there is a significant difference in the variances of the results for student computer literacy profiles. The formula is:

where

To compute the Bartlett's test statistic, even though there are several commercially available software for statistical computation, a customized Microsoft Excel solution for the Bartlett's test was developed and utilised. This is due to the fact that in some cases, a variance of zero existed amongst the data sets. This unusual situation made it impossible for proprietary software (SPSS, Minitab 15, Dataplot) to obtain the necessary solutions. The Excel solution was tested by comparing its output with that of proprietary software using well structured data sets with non-zero variances.

In addition to this, Welch's t-Test (Wikipedia, 2009b; Wikipedia, 2009c) is used to determine the significance or otherwise of differences in the means of the samples. To facilitate this, the Welch-Satterthwaite equation for computing degrees of freedom is applied. The formulae are respectively:

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{\sigma_1^2}{N_1} + \frac{\sigma_2^2}{N_2}}} \qquad \text{and} \qquad df = \frac{\left(\frac{\sigma_1^2}{N_1} + \frac{\sigma_2^2}{N_2}\right)^2}{\frac{\sigma_1^4}{N_1^2(N_1 - 1)} + \frac{\sigma_2^4}{N_2^2(N_2 - 1)}}$$

In addition to this, the study utilises SPSS 11.0 to compute the Analysis of Variance (ANOVA) for select parameters of data collected from the different

study populations. In consideration of the findings of Settlage *et al* (2000) that frontier methods, specifically the Cobb Douglas form are superior to data envelopment analysis, four frontier methods (Linear, exponential, semilog and Cobb Douglas) are used for the analysis as utilised by Aral *et al* (2008). The best fitting model shall be assumed to be the one which has the highest $R^2$ value.

Being primarily a behavioural study in an academic environment with knowledge workers as the respondents, and also considering the findings of Laursen and Mahnke (2000) in a similar knowledge worker study, we expect the $R^2$ estimates derived in this study to be similar to theirs.

All statistical, arithmetic and mathematical operations are carried out using Microsoft Office Excel 2007 and SPSS 11.0 deployed on a computer with an x86 Family 15 model 4 Stepping 1 Intel ~2394Mhz processor, 2GB physical memory, 250GB HDD, 4.0 GB virtual memory, running on a Microsoft Windows Vista Ultimate operating system.

## 3.7 MODELS AND MODELLING APPROACH

Model building is a pervasive feature of Operations Research in practice (Beer, 1966). In this study, the following models and modelling approaches are to be utilised:

1. Dataflow Diagrams (DFDs).
2. Multiple regression models.
3. Eclectic blend of Enterprise analysis and Strategic Analysis to formulate a logical model of the desired information architecture of the University. This will be achieved through the creation of a data matrix based on organisational critical success factors (CSFs).

## 3.8 SYSTEMS DEVELOPMENT PROCEDURES

The procedural layout of systems development is in consonance with the essentials of the systems approach as explained by Laudon and Laudon (1998). The steps are:

1. Systems Analysis.
2. Systems Design (Logical).
3. Programming.
4. Testing.
5. Conversion.
6. Production and Maintenance.

In this study, description of items 1 – 5 are considered trivial, hence only the maintenance procedure would be described in some detail.

### Production and Maintenance

Maintenance should increase the availability and reliability of systems and equipment, and decrease their repair time (Viles & Puente, 2005 p. 40). In this study, we adopt the Functional Analysis and Maintenance technique developed by Viles and Puente for making corrective maintenance easier and more efficient. This method involves two steps: the design of the *functional network* and the *functional study*.

Functional Network

The functional network is a graphical representation used to define, organise and connect the different functions that the equipment or system and its modules and components must fulfil. The network has two element types which must be considered: function and control.

Functional Study

The functional study is the analysis of each separate function in the network and deals with the failures that could occur during its operation, their possible

involvement in the failure of higher-level functions and the state or warnings of the controls in the case of a breakdown. With the functional study, we gather the relevant information of each subsystem for a function. This enables us to identify which repairable device has caused the breakdown. Furthermore, to effectively *control* the system to be designed, an elaborate information policy would have to be created that meets the needs and aspirations of all the stakeholders in the *integrated information delivery system (IIDS) project*.

## 3.9 CONNECTIVE SUMMARY

In this chapter, we have elucidated the procedure used in carrying out this study. The chapter has detailed the design methodology considering the population strata, sample spaces and sampling procedure as well as the models and modelling approaches to be made use of. In the next chapter, we shall be examining the data generated from our surveys and creating our logical models which shall guide the programming phase.

# CHAPTER FOUR
# ANALYSIS AND PRESENTATION OF DATA

## 4.1 INTRODUCTION

This chapter showcases the survey findings and relevant analysis. It also describes the tools and techniques used for software development as well as the application software. In describing the developed software, both the logical structure and the interfaces are described in some detail. Being an OR study, the chapter does not neglect to discuss implementation in the organisation as well as how it is expected to affect the business process. Hence, there are two subsections devoted to these concerns. A connective summary rounds of the chapter, giving a *bird's eye view* of the study details.

## 4.2 SURVEY FINDINGS

The questionnaires distributed elicited profound discoveries on the information profile of academic staff and students of the study area. Tables 4 – 13 below show these results.

TABLE 4: DESCRIPTIVE STATISTICS OF SURVEY DATA FROM MANAGEMENT STAFF

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| **Mean** | 13.14 | 4.50 | 17.64 | 1.43 | 0.71 | 1.57 |
| **Median** | 16.00 | 0.00 | 18.00 | 1.00 | 1.00 | 1.00 |
| **Maximum** | 24.00 | 21.00 | 27.50 | 2.00 | 2.00 | 3.00 |
| **Minimum** | 2.00 | 0.00 | 4.00 | 1.00 | 0.00 | 1.00 |
| **Range** | 22.00 | 21.00 | 23.50 | 1.00 | 2.00 | 2.00 |
| **Standard Deviation** | 8.47 | 7.75 | 7.39 | 0.53 | 0.76 | 0.79 |
| **Variance** | 71.81 | 60.08 | 54.56 | 0.29 | 0.57 | 0.62 |
| **Average of Absolute Deviations** | 7.27 | 5.43 | 5.12 | 0.49 | 0.61 | 0.65 |

***Key:***

*A: Number of years employed in FUTY*
*B: Number of years employed in other institutions of higher learning*
*C: Total number of years employed in institutions of higher learning*
*D: Number of functional computers in office*
*E: Number of hours spent using the computers in the office*
*F: Regularity of visits to university website*

***Source:*** *Field Survey, 2006*

In addition, the survey revealed that of the seven management staff of the university, only four had any formal computer training and only those four owned personal computers. Again it was noted that these four were more frequent visitors to the university web site. One may reasonably infer from these results that for this category of respondents, formal computer training is of vital importance in the development of IS literacy.

Generally, this category of respondents were of the view that any system wide information system should incorporate the following functions; keeping track of mails and memos, scheduling of appointments with reminders, maintaining staff and student personal data, keeping track of financial matters, maintaining data for appraisals, applications and grant of leave to staff, confirmation of appointments, salary reviews, reader services, selective dissemination of information, cataloguing, utility billing and inventory management.

TABLE 5: DESCRIPTIVE STATISTICS OF MANAGEMENT STAFF RATING OF EXISTING INFORMATION SYSTEMS IN THEIR OFFICES (LIKERT SCALE OF 0 – 5, WHERE 0 = "UNABLE TO ASSESS", 1 = "VERY POOR", 2 = "POOR", 3 = "GOOD", 4 = "VERY GOOD" AND 5 = "EXCELLENT")

| | A | B | C | D | E | F | G |
|---|---|---|---|---|---|---|---|
| **Mean** | 4.00 | 3.57 | 4.57 | 2.86 | 4.00 | 3.57 | 2.43 |
| **Median** | 4.00 | 4.00 | 5.00 | 3.00 | 4.00 | 4.00 | 3.00 |
| **Maximum** | 4.00 | 4.00 | 5.00 | 4.00 | 4.00 | 4.00 | 4.00 |
| **Minimum** | 4.00 | 3.00 | 4.00 | 2.00 | 4.00 | 3.00 | 1.00 |
| **Range** | 0.00 | 1.00 | 1.00 | 2.00 | 0.00 | 1.00 | 3.00 |
| **Standard Deviation** | 0.00 | 0.53 | 0.53 | 0.90 | 0.00 | 0.53 | 1.40 |
| **Variance** | 0.00 | 0.29 | 0.29 | 0.81 | 0.00 | 0.29 | 1.95 |
| **Average of Absolute Deviations** | 0.00 | 0.49 | 0.49 | 0.73 | 0.00 | 0.49 | 1.22 |

***Key:***
*A: Efficient utilisation of available resources*
*B: Storage of existing records and data items*
*C: Ability to retrieve stored data and records*
*D: Ability to forecast future trends from existing data*
*E: Accuracy of data and information-related services*
*F: Cost-effectiveness of information delivery function*
*G: Speed and efficiency of data and information interchange between subunits*
***Source:*** *Field Survey, 2006*

All management staff highly rated their office information systems in the existing records and data items, ability to retrieve stored data and records, and accuracy. The other parameters show lower rating. The variances were quite small, indicating widespread agreement on rating of the various parameters, hence consistency of performance across sub-units. Levene's test for equality of variances degenerated due to the presence of zero-value variances for two of the variables under investigation. Hence, the Bartlett's test for equality of variances (see computation in Appendix IX) was used to manually ascertain the equality of variances. The two "zero-variance" variables indicate that management staff are unanimous in strongly agreeing that the existing systems are efficient in the utilisation of available resources and that they generate accurate data and information related services. The Welch's t-Test (see test results in Appendix VII) further indicates that there is significant difference between information literacy and computer literacy of academic staff. It also shows a significant difference between information literacy and perceived fiscal value of constant internet access. Negative correlation between information literacy and exposure to computers (–0.3885) as well as between information literacy and years of service (–0.1297) was also noted.

TABLE 6: DESCRIPTIVE STATISTICS OF SURVEY DATA FROM ACADEMIC STAFF

| | A | B | C | D | E | F | G |
|---|---|---|---|---|---|---|---|
| **Mean** | 2.20 | 5.28 | 7.48 | 1.18 | 1.73 | 1.90 | 0.63 |
| **Median** | 2.00 | 2.50 | 4.00 | 1.00 | 2.00 | 1.00 | 0.00 |
| **Maximum** | 6.00 | 21.00 | 27.00 | 4.00 | 3.00 | 4.00 | 4.00 |
| **Minimum** | 1.00 | 1.00 | 2.00 | 0.00 | 1.00 | 1.00 | 0.00 |
| **Range** | 5.00 | 20.00 | 25.00 | 4.00 | 2.00 | 3.00 | 4.00 |
| **Standard Deviation** | 1.47 | 6.14 | 7.49 | 1.30 | 0.60 | 1.28 | 1.15 |
| **Variance** | 2.16 | 37.64 | 56.10 | 1.69 | 0.36 | 1.63 | 1.32 |
| **Average of Absolute Deviations** | 1.04 | 4.52 | 5.54 | 1.00 | 0.51 | 1.08 | 0.84 |

***Key:***
*A: Number of years employed in FUTY*

*B: Number of years employed in other institutions of higher learning*
*C: Total number of years employed in institutions of higher learning*
*D: Key academic positions occupied in FUTY*
*E: Qualifications*
*F: Number of functional computers available in the department*
*G: Number of hours spent using the computers in the office*
***Source:*** *Field Survey, 2006*

TABLE 7: DESCRIPTIVE STATISTICS OF INFORMATION LITERACY PROFILE OF ACADEMIC STAFF (LIKERT SCALE OF 0 – 4, WHERE 0 = "UNABLE TO ASSESS", 1 = "VERY POOR", 2 = "POOR", 3 = "GOOD", AND 4 = "VERY GOOD")

| | A | B | C | D | E | F | G | H | J | K |
|---|---|---|---|---|---|---|---|---|---|---|
| **Mean** | 3.40 | 3.43 | 3.40 | 3.33 | 3.60 | 3.46 | 3.38 | 3.08 | 3.17 | 3.50 |
| **Median** | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 3.00 | 3.00 | 4.00 |
| **Maximum** | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 |
| **Minimum** | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 2.00 | 2.00 | 1.00 |
| **Range** | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 2.00 | 2.00 | 3.00 |
| **Standard Deviation** | 1.22 | 1.03 | 1.22 | 1.21 | 0.93 | 0.96 | 1.05 | 0.80 | 0.77 | 1.04 |
| **Variance** | 1.48 | 1.07 | 1.48 | 1.46 | 0.86 | 0.92 | 1.11 | 0.64 | 0.60 | 1.08 |
| **Average of Absolute Deviations** | 0.96 | 0.83 | 0.96 | 0.98 | 0.64 | 0.73 | 0.88 | 0.65 | 0.65 | 0.80 |

***Key:***
*A: Computers can be used to make work easier*
*B: Computers can be used to provide prompt reports*
*C: Computers can be used to promptly produce transcripts*
*D: Computers can be used to promptly produce result sheets for students*
*E: Departmental records should be kept on computer databases*
*F: Student registration should be computerised*
*G: There is need for unrestricted internet access to all academic staff*
*H: Delays in obtaining information in the university are too great*
*J: Delays in obtaining information-related services in the university are too great*
*K: Every academic staff should have a computer allocated to him/her*
***Source:*** *Field Survey, 2006*

It can be seen that the information literacy profile of academic staff is quite high, with mean responses on all parameters ranging from 3.08 to 3.60 on a four-point Likert scale. Correlation between information literacy and length of service was –0.0212 while that between information literacy and exposure to computers was 0.1236. Hence, it becomes evident from details gathered from academics and management staff that these two parameters have little to do with the level of information literacy among these categories of staff in FUTY.

TABLE 8: DESCRIPTIVE STATISTICS OF COMPUTER LITERACY PROFILE OF ACADEMIC STAFF (LIKERT SCALE OF 0 – 5, WHERE 0 = "UNABLE TO ASSESS", 1 = "VERY POOR", 2 = "POOR", 3 = "GOOD", 4 = "VERY GOOD" AND 5 = "EXCELLENT")

| | A | B | C | D | E | F | G | H | J | K |
|---|---|---|---|---|---|---|---|---|---|---|
| **Mean** | 2.55 | 2.38 | 3.23 | 2.75 | 1.50 | 1.83 | 1.83 | 1.53 | 1.33 | 1.73 |
| **Median** | 3.00 | 2.00 | 4.00 | 2.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| **Maximum** | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 |
| **Minimum** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Range** | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 |
| **Standard Deviation** | 2.00 | 1.86 | 1.70 | 1.78 | 1.85 | 1.58 | 1.77 | 2.00 | 1.83 | 1.93 |
| **Variance** | 4.00 | 3.47 | 2.90 | 3.17 | 3.44 | 2.51 | 3.12 | 4.00 | 3.35 | 3.74 |
| **Average of Absolute Deviations** | 1.76 | 1.66 | 1.40 | 1.54 | 1.53 | 1.36 | 1.52 | 1.71 | 1.42 | 1.66 |

***Key:***
*A: Spreadsheets*
*B: Databases*
*C: Word Processors*
*D: Application software in their own discipline*
*E: Equation editors*
*F: Computer hardware maintenance*
*G: Assembling computers*
*H: Website design*
*J: Computer simulation*
*K: Programming*
***Source:*** *Field Survey, 2006*

With the possible exception of word processors, the descriptive statistics show that the level of computer literacy of academic staff is at best pathetic with an index of 34.43%. This index is the grouped median of the set of responses obtained across parameters a – k. Whereas all but a few respondents identified themselves as computer literate, it becomes evident that this literacy is restricted mainly to typing memos and letters. Only very few respondents indicated any considerable level of computer literacy across parameters.

Generally, academic staff identified processing of staff and student personal records, student admission and placement, student academic records, student registration, research finding documentation, lectures, appraisal records, and leave applications as functions which they believe should be computerised. Also,

a few respondents were greatly dissatisfied with the effectiveness of the MIS unit of the university.

TABLE 9: DESCRIPTIVE STATISTICS OF ACADEMIC STAFF PERCEPTIONS OF THE FISCAL VALUE OF UNRESTRICTED INTERNET ACCESS
(LIKERT SCALE OF 0 – 5, WHERE 0 = "UNABLE TO ASSESS", 1 = "VERY POOR", 2 = "POOR", 3 = "GOOD", 4 = "VERY GOOD" AND 5 = "EXCELLENT")

| | **AMOUNT (SCALE)** |
|---|---|
| **Mean** | 2.17 |
| **Median** | 2.00 |
| **Maximum** | 4.00 |
| **Minimum** | 0.00 |
| **Range** | 4.00 |
| **Standard Deviation** | 1.53 |
| **Variance** | 2.33 |
| **Average of Absolute Deviations** | 1.19 |

***Key:***
*0: It should be free*
*1: Below ₦500.00*
*2: ₦500.00 – ₦1,000.00*
*3: ₦1,000.00 – ₦2,000.00*
*4: ₦2,000.00 – ₦3,000.00*
*5: Above ₦3,000.00*
***Source:*** *Field Survey, 2006*

From the descriptive statistics, it becomes evident that whilst a few academic staff are of the opinion that unrestricted internet access should be free, the general thinking is that a monthly charge of between ₦500.00 and ₦1,000.00 would be acceptable with a variance of 2.33. It is notable that no respondent indicated an acceptance of a charge in excess of ₦3,000.00. This, of course, negates our assumption that academic staff are willing to pay ₦3,000.00 monthly for unrestricted internet access in their offices. As such, it would be important for decision makers who wish to finance such a system to realise that any attempt to obtain funding through direct deduction of staff salaries in excess

of ₦1,000.00 is likely to be resisted by the staff members concerned. Alternatives would have to be sought therefore.

TABLE 10: DESCRIPTIVE STATISTICS OF SURVEY DATA FROM FUTY STUDENTS (LIKERT SCALE OF 0 - 5, WHERE 0 = "UNABLE TO ASSESS", 1 = "VERY POOR", 2 = "POOR", 3 = "GOOD", 4 = "VERY GOOD" AND 5 = "EXCELLENT")

| | A | B | C | D | E |
|---|---|---|---|---|---|
| **Mean** | 2.14 | 0.51 | 0.17 | 0.56 | 0.46 |
| **Median** | 2.00 | 0.00 | 0.00 | 1.00 | 0.00 |
| **Maximum** | 4.00 | 4.00 | 1.00 | 1.00 | 4.00 |
| **Minimum** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Range** | 4.00 | 4.00 | 1.00 | 1.00 | 4.00 |
| **Standard Deviation** | 0.87 | 1.07 | 0.38 | 0.50 | 0.94 |
| **Variance** | 0.76 | 1.14 | 0.14 | 0.25 | 0.89 |
| **Average of Absolute Deviations** | 0.68 | 0.76 | 0.76 | 0.49 | 0.68 |

***Key:***
*A: Qualification*
*B: Number of functional computers available for use*
*C: Ownership of Personal computer*
*D: Access to computing facilities*
*E: Number of hours spent using the departmental computers*
***Source:*** *Field Survey, 2006*

From table 10, we observe that with a variance of 0.89, students are, on average, able to spend four hours or less per week making use of the computer facilities available to them in their departments. Considering the ratio of 15,000 students to less than one hundred and fifty computers available, the reasons for this are not far fetched. The facilities available are just not adequate. This raises the issue of how FUTY would be able to provide 5,625,000 man-hours per semester of internet access to its student body.

This figure represents five hours a day for five days in a week for a semester of fifteen weeks. Going by the estimated figure of 15,000 students, this reduces to 375 man-hours of access per student per semester. To do this the university would have to think of either providing unlimited access to its entire student

body, or providing the facilities that when properly scheduled would make the required quantity of internet man-hours available to all students.

TABLE 11: DESCRIPTIVE STATISTICS OF INFORMATION LITERACY PROFILE OF FUTY STUDENTS (LIKERT SCALE OF 0 – 4, WHERE 0 = "VERY POOR", 1 = "POOR", 2 = "GOOD", 3 = "VERY GOOD" AND 4 = "EXCELLENT")

| | A | B | C | D | E | F | G | H |
|---|---|---|---|---|---|---|---|---|
| **Mean** | 2.78 | 3.68 | 3.19 | 3.30 | 3.04 | 2.71 | 2.72 | 3.32 |
| **Median** | 3.00 | 4.00 | 4.00 | 4.00 | 4.00 | 3.00 | 3.00 | 4.00 |
| **Maximum** | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 |
| **Minimum** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Range** | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 | 4.00 |
| **Standard Deviation** | 1.36 | 0.76 | 1.12 | 1.04 | 1.36 | 1.11 | 1.17 | 1.18 |
| **Variance** | 1.84 | 0.58 | 1.26 | 1.08 | 1.84 | 1.23 | 1.37 | 1.39 |
| **Average of Absolute Deviations** | 1.10 | 0.49 | 0.86 | 0.76 | 1.05 | 0.85 | 0.93 | 0.92 |

***Key:***

*A: Computers should be used regularly for classroom instruction*
*B: Computers should be used to produce student results speedily*
*C: Departmental records ought to be kept on electronic databases*
*D: Student registration should be computerized*
*E: There is a need for unrestricted internet access for all students*
*F: Delays in acquiring information in the University are too great*
*G: Delays in getting information services in the University are too great*
*H: Every student should have a computer allocated to him/her*

***Source:*** *Field Survey, 2006*

TABLE 12: DESCRIPTIVE STATISTICS OF COMPUTER LITERACY PROFILE OF FUTY STUDENTS (LIKERT SCALE OF 0 – 5, WHERE 0 = "UNABLE TO ASSESS", 1 = "VERY POOR", 2 = "POOR", 3 = "GOOD", 4 = "VERY GOOD" AND 5 = "EXCELLENT")

| | A | B | C | D | E | F | G | H | J | K |
|---|---|---|---|---|---|---|---|---|---|---|
| **Mean** | 1.69 | 1.70 | 2.19 | 1.48 | 1.15 | 1.53 | 1.08 | 1.18 | 0.92 | 1.30 |
| **Median** | 2.00 | 1.50 | 2.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| **Maximum** | 5.00 | 5.00 | 5.00 | 5.00 | 4.00 | 5.00 | 4.00 | 5.00 | 4.00 | 5.00 |
| **Minimum** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| **Range** | 5.00 | 5.00 | 5.00 | 5.00 | 4.00 | 5.00 | 4.00 | 5.00 | 4.00 | 5.00 |
| **Standard Deviation** | 1.46 | 1.35 | 1.70 | 1.57 | 1.28 | 1.55 | 1.23 | 1.41 | 1.08 | 1.36 |
| **Variance** | 2.14 | 1.83 | 2.89 | 2.47 | 1.63 | 2.39 | 1.51 | 1.99 | 1.17 | 1.84 |
| **Average of Absolute Deviations** | 1.26 | 1.17 | 1.47 | 1.35 | 1.01 | 1.30 | 1.02 | 1.15 | 0.88 | 1.10 |

***Key:***
*A: Spreadsheets*
*B: Databases*
*C: Word Processors*
*D: Application software in their own discipline*
*E: Equation editors*
*F: Computer hardware maintenance*
*G: Assembling computers*
*H: Website design*
*J: Computer simulation*
*K: Programming*
***Source:*** *Field Survey, 2006*

It can be seen that the information literacy profile of FUTY students is appallingly low, with mean responses on all parameters ranging from 0.92 to 2.19 on a four-point Likert scale. Correlation between information literacy and computer literacy was 0.28 while that between information literacy and exposure to computers was 0.29. Hence, it becomes evident from details gathered from students that these two parameters have little to do with the level of information literacy among students in FUTY. This is proven by the Welch's t-Test results indicated in Appendix VII.

TABLE 13: DESCRIPTIVE STATISTICS OF FUTY STUDENT PERCEPTIONS OF THE FISCAL VALUE OF UNRESTRICTED INTERNET ACCESS
(LIKERT SCALE OF 0 – 5, WHERE 0 = "UNABLE TO ASSESS", 1 = "VERY POOR", 2 = "POOR", 3 = "GOOD", 4 = "VERY GOOD" AND 5 = "EXCELLENT")

| | AMOUNT (SCALE) |
|---|---|
| **Mean** | 0.93 |
| **Median** | 0.00 |
| **Maximum** | 5.00 |
| **Minimum** | 0.00 |
| **Range** | 5.00 |
| **Standard Deviation** | 1.53 |
| **Variance** | 2.35 |
| **Average of Absolute Deviations** | 1.15 |

***Key:***
*0: It should be free*
*1: Below ₦500.00*
*2: ₦500.00 – ₦1,000.00*
*3: ₦1,000.00 – ₦2,000.00*
*4: ₦2,000.00 – ₦3,000.00*
*5: Above ₦3,000.00*
***Source:*** *Field Survey, 2006*

Again, as in staff findings from the academic staff survey, it is apparent that the desire for internet access is not backed up with a willingness to part with any considerable sum of money for it. With a variance of 2.35, FUTY students are only willing to part with ₦500.00 or less per semester for unrestricted internet access. Thus if decision makers are thinking of financing such a venture from direct funding from either students or academic staff members, they are likely to be met with some measure of resistance. This sort of reaction should be anticipated.

## 4.3 REGRESSION MODELS

For the analyses, four functional forms for frontier estimation (Linear, Exponential, Semi Log, Cobb Douglass) are used to model responses from academic staff with the best fitting model selected. The best fits were gotten by using the Cobb-Douglass and the Exponential forms for staff and students

respectively. These forms were chosen in consideration of the findings by Settlage *et al* (2000) that frontier methods, specifically the Cobb Douglas approximating form, are superior to data envelopment analysis. This is emphasized by the application of the Cobb Douglas form in Aral *et* al (2008). The $R^2$ estimates found in this study were similar to those found by Laursen and Mahnke (2000) in a similar knowledge-worker study.

The coefficients, models summaries and ANOVA tables are presented below.

### 4.3.1 FUTY Academic Staff

**Standardized Coefficients**

| Function | $X_1$ | $X_2$ | $X_3$ | $X_4$ | $X_5$ | $X_6$ | $X_7$ | $X_8$ | $X_9$ | $X_{10}$ |
|---|---|---|---|---|---|---|---|---|---|---|
| Linear | -0.094 | -2.499 | -9.258 | 9.254 | -8.478 | -4.809 | 5.285 | -11.165 | 3.479 | 17.580 |
| Exponential | 0.059 | -2.348 | -8.772 | 8.678 | -7.915 | -4.415 | 4.995 | -10.634 | 3.093 | 16.765 |
| Semi Log | -0.076 | -2.762 | -14.892 | 8.993 | -8.296 | 4.678 | 13.187 | -2.397 | -5.115 | 6.658 |
| Cobb Douglas | -0.047 | -2.562 | -14.458 | 8.470 | -7.801 | 4.426 | 12.803 | -2.385 | -4.917 | 6.478 |

**Key**

$X_1$ Internet appreciation
$X_2$ Proficiency with electronic spreadsheets
$X_3$ Proficiency with database management
$X_4$ Proficiency with word processors
$X_5$ Proficiency with application software in own discipline
$X_6$ Proficiency with equation editors
$X_7$ Ability to perform hardware maintenance
$X_8$ Ability to configure and assemble computers
$X_9$ Proficiency with website design
$X_{10}$ Ability to perform computer simulation
$X_{11}$ Programming skill
Dependent Variable: *Information Literacy*

**Model Summary**

| Function | R | $R^2$ | Std Error | F change | $df_1$ | $df_2$ | Sig. F change | Durbin Watson |
|---|---|---|---|---|---|---|---|---|
| Linear | 0.729 | 0.531 | 7.67272 | 3.285 | 10 | 29 | 0.006 | 1.791 |
| Exponential | 0.733 | 0.538 | 0.30890 | 3.377 | 10 | 29 | 0.005 | 1.752 |
| Semi Log | 0.729 | 0.531 | 7.67272 | 3.285 | 10 | 29 | 0.006 | 1.791 |
| **Cobb Douglas** | **0.733** | **0.538** | **0.30890** | **3.377** | **10** | **29** | **0.005** | **1.752** |

**ANOVA Table: Cobb Douglass**

| Model | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Regression | 3.222 | 10 | 0.322 | 3.377 | 0.005 |
| Residual | 2.767 | 29 | 0.095 | | |
| **TOTAL** | 5.989 | 39 | | | |

### 4.3.2 FUTY Students

**Standardized Coefficients**

| Function | $X_1$ | $X_2$ | $X_3$ | $X_4$ | $X_5$ | $X_6$ | $X_7$ | $X_8$ | $X_9$ | $X_{10}$ | $X_{11}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Linear | 0.233 | 0.283 | 0.228 | 0.346 | -0.446 | 0.197 | -0.597 | 0.373 | -0.118 | 0.008 | 0.202 |
| Exponential | 0.202 | 0.195 | 0.275 | 0.136 | -0.305 | 0.037 | -0.355 | 0.280 | -0.097 | -0.001 | 0.238 |
| Semi Log | 0.160 | 0.702 | 0.468 | -0.041 | -0.708 | 0.229 | -0.099 | 0.462 | -0.863 | 0.413 | -0.006 |
| Cobb Douglas | 0.149 | 0.473 | 0.411 | -0.095 | -0.472 | 0.113 | 0.027 | 0.232 | -0.534 | 0.254 | 0.078 |

**Key**

$X_1$ Internet appreciation
$X_2$ Proficiency with electronic spreadsheets
$X_3$ Proficiency with database management
$X_4$ Proficiency with word processors
$X_5$ Proficiency with application software in own discipline
$X_6$ Proficiency with equation editors
$X_7$ Ability to perform hardware maintenance
$X_8$ Ability to configure and assemble computers
$X_9$ Proficiency with website design
$X_{10}$ Ability to perform computer simulation
$X_{11}$ Programming skill

Dependent Variable: *Information Literacy*

**Model Summary**

| Function | R | $R^2$ | Std Error | F change | $df_1$ | $df_2$ | Sig. F change | Durbin Watson |
|---|---|---|---|---|---|---|---|---|
| Linear | 0.497 | 0.247 | 5.25993 | 5.614 | 11 | 188 | 0.000 | 1.728 |
| Exponential | 0.357 | 0.128 | 1.67260 | 2.501 | 11 | 188 | 0.006 | 1.763 |
| **Semi Log** | **0.569** | **0.324** | **4.98409** | **8.196** | **11** | **188** | **0.000** | **1.858** |
| Cobb Douglas | 0.441 | 0.194 | 1.60725 | 4.127 | 11 | 188 | 0.000 | 1.906 |

**ANOVA Table: Semi Log**

| Model | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Regression | 2239.661 | 11 | 203.606 | 8.196 | 0.000 |
| Residual | 4670.134 | 188 | 24.841 | | |
| **TOTAL** | 6909.795 | 199 | | | |

## 4.4 SOFTWARE DEVELOPMENT

The application software created was produced making use of a combination of programming tools and techniques. The databases were created using MS Access 2003 and the program interfaces were developed with Visual Basic 6.0. The help tools and the operations manual were created using Hypertext Mark-up Language (HTML). *Rapid Prototyping* was the system development lifecycle approach which governed the entire development process. The developed software was tested using student academic data from the department of

Information Technology, FUTY. This set of sample data was used to observe the interaction between the various data items and the final information product.

## 4.5 LOGICAL MODEL OF DEVELOPED SOFTWARE

The software created was logically modelled after the popular Microsoft windows program format. The internal structure is derived from the Microsoft Visual Basic data access model illustrated in figure 1 below. This structure is a three tier system comprising the data storage facility (data), activeX data objects (middle tier) and user forms for data entry and access (client). In the software, the data tier is made up of four Microsoft Access databases; security.mdb, departmentResults.mdb, staff.mdb and students.mdb. These are accessed from over one hundred user forms through a combination of various activeX data objects and Structured Query Language (SQL) statements.

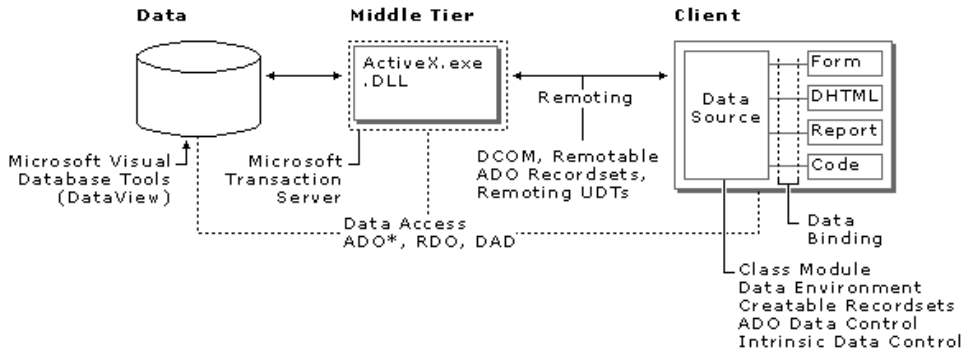


*Figure 1: Software Logical Structure*
*Source: Microsoft (2005)*

## 4.6 SOFTWARE INTERFACES

The interface is a very crucial aspect of any software design. It is the point of interaction between man and machine. Care must be taken to consider the end user's skill, preferences, difficulties and abilities. The end user is not likely to possess adequate skill to appreciate the level of complexity involved in the

program itself. His primary concern is getting his job done on time and with relative ease. Thus, the interfaces designed are as a result of careful consideration of various factors gleaned from the questionnaires issued and personal interaction/observation of potential end users. What follows is a selection of representative samples of the user interface created.

### *4.6.1 Login Interface*

At run time, the user is required to log into the program. This interface provides for users to gain access to those aspects of the system they are authorized to make use of. The three fields required here are the *User Name*, *Security level*, and *Password*. The concept is that every user shall have a password and security level designation which grants access to the program and its elements. Unless all three fields correspond to the entries already within the memory of the system, the user is denied access to the system. Should the user forget any of the login elements, the network administrator can have them replaced or recovered after proper identification. It is assumed that the office of the network administrator would be domiciled in the university MIS office.

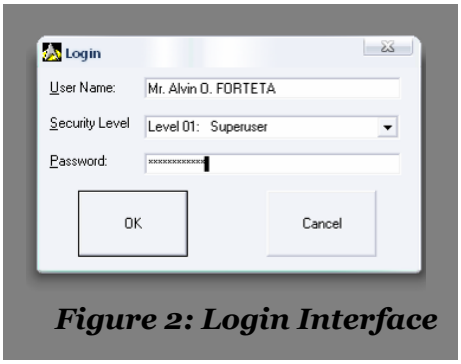


***Figure 2: Login Interface***

There are ten security levels in the developed program. They correspond to the various cadres of end users expected to access the program to perform one function or the other. These levels are:

1. *Superuser*: This is the network administrator or other person charged with the technical responsibility to oversee the efficient functioning of the entire integrated information delivery system

(IIDS). This confers global DENY NONE access to the system. The superuser is also granted access to the source codes through the activation of a special command button not accessible to other users. This gives this user the ability to modify the program to any extent at run time even after deployment.

2. *Management*: This comprises the principal officers of the university. They are granted universal READ ONLY rights to the system and data items contained.
3. *Dean/HOD*: The Deans of Schools and the Heads of all academic departments fall into this category. They have global read only rights to all data items. However, they also have READ WRITE access to staff appraisal modules and can add new staff users to the system or deny access to any user (staff or student) within their School or Department as the case may be.
4. *Examination Officer*: The Examination Officers of all academic departments in the university. They are granted global READ WRITE access to all Departmental records for their department. They are authorized to add student users from their department to the system. They are denied access to all other modules.
5. *Academic Staff*: All academic staff (lecturers) can log in and have READ WRITE access to appraisal data and to modules for the courses they teach within the period permitted by the network administrator. They also have READ ONLY access to all departmental records but are denied access to all other modules.
6. *Admin & Technical Staff*: This category of staff possess WRITE only access to modules in their department/unit. They can enter

records but cannot edit or delete anything. Should there be genuine need to perform these actions, the network administrator should be called upon to grant them access for the required period.

7. *Post-Graduate Student*: These students can access registration modules as well as access non-sensitive departmental data. They also have access to the Security Complaints Interface and can lodge complaints online in real time. They can also access the library catalogues and Library Book Reservation Interface and request reservation of library books.
8. *Undergraduate Student*: Same as for Post-Graduate Students but are denied access to all departmental data.
9. *Consultancy Student*: Same as for Post-Graduate students except that they cannot access the library modules and are denied access to departmental data.
10. *Pre-Degree Student*: Same as for consultancy students.

### 4.6.2 Change Password Interface

It is normal practice amongst computer users to change passwords every now and again. In fact, in most operating systems, administrators are required to change passwords every fortnight or indicate that they do not wish to change. This need is recognised in the IIDS. The module provides options for any user who has already logged in to modify the password. User names however will not be subject to modification as users will be required to use their official names to log in. Where a user officially changes name, the network administrator will update the databases with the new name and the user name is updated.

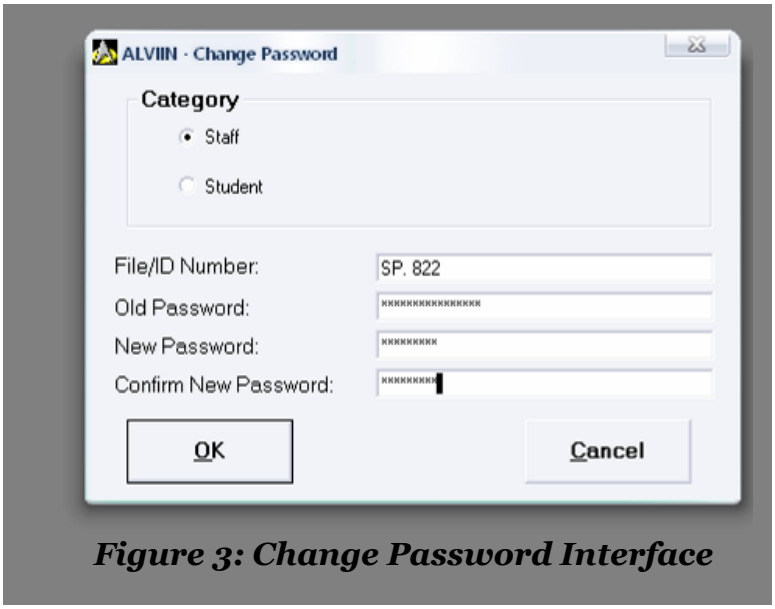


*Figure 3: Change Password Interface*

### 4.6.3 Main Multiple Document Interface (MDI) Interface

This is the first point of interaction between end users and the program. The interface comes up once the user successfully logs in. The design of this interface is patterned after normal windows interfaces. It is replete with specialized drop-down menus and familiar icons to perform standardized functions. The central grey area is meant to hold the MDI child forms which are part of the program. Some of the other interfaces may open up centre screen or full screen depending on their individual peculiarities.

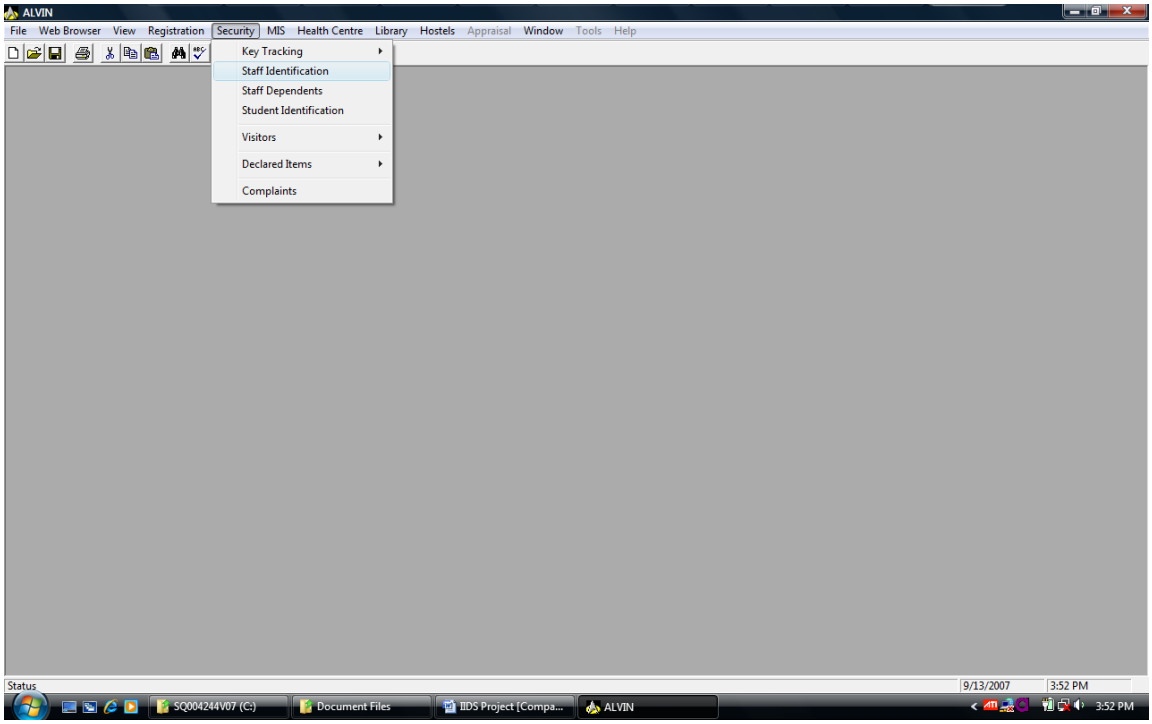


***Figure 4: Main Multiple Document Interface (MDI) Form***

### *4.6.20 Student Registration Interface*

Unlike the present manual, paper-based system of course registration, the ALVIN provides for electronic registration of student and staff personal, academic, and appraisal data. This is done through a series of data capture forms embedded in the program. For students' registration, the input form is shown in figure 5 below while figure 6 gives the design of the course registration interface for students. These forms enable capture of all data items presently collectable by the paper-based system presently in use. And provides for a greater level of accuracy, flexibility, and reliability of the data collected.

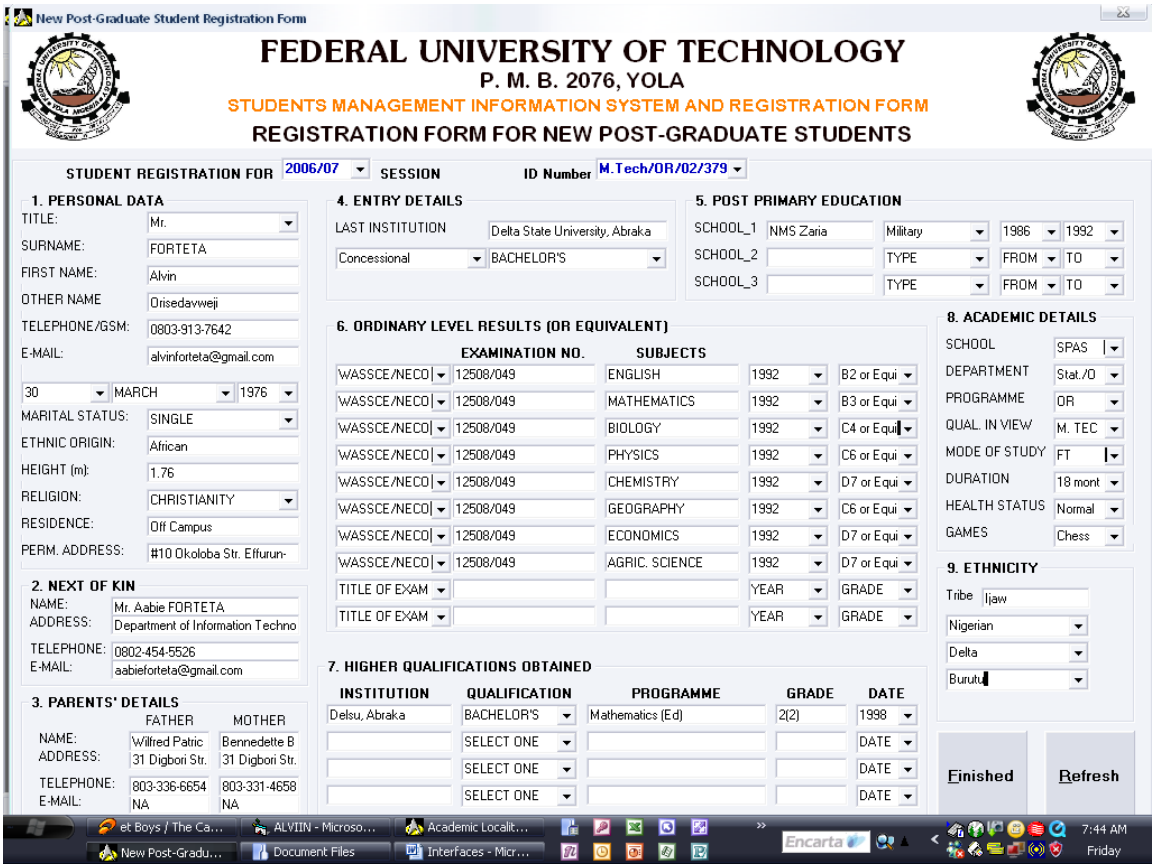


*Figure 5: Student Registration Interface*

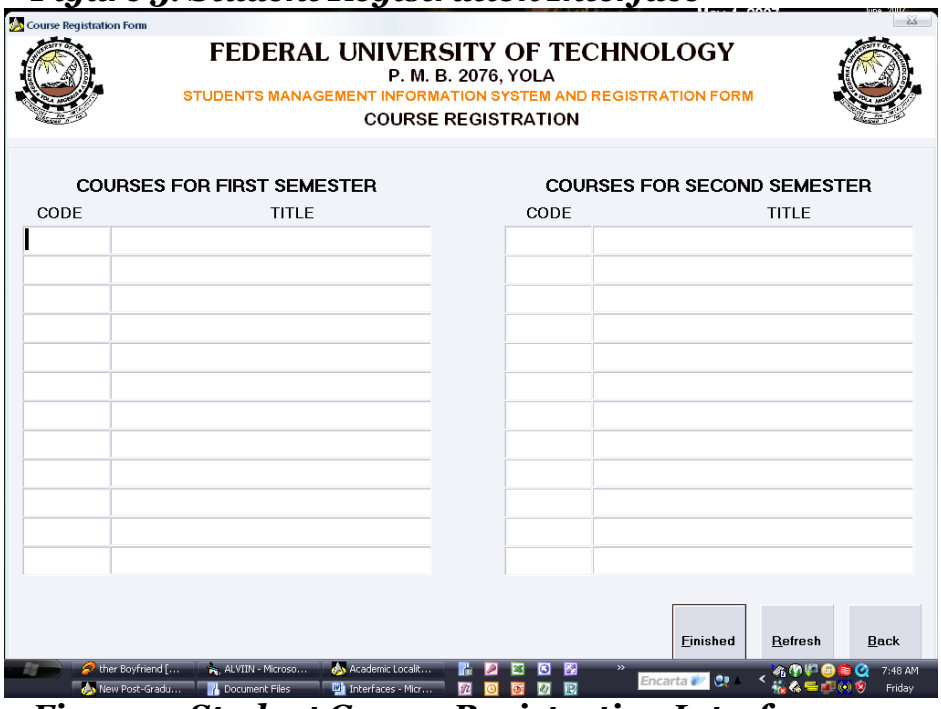


*Figure 7: Student Course Registration Interface*

# CHAPTER FIVE
# SUMMARY RECOMMENDATIONS AND CONCLUSION

## 5.1 INTRODUCTION

This chapter summarizes the entire study, highlights major findings and gives recommendations to various "stakeholders" in the information delivery process of FUTY and related institutions. The Nigerian military is not left out, receiving a *fair dose* of sound counsel on the relevance of OR to the *profession of arms*.

## 5.2 SUMMARY

This project has been undertaken through an intricate process of system analysis and design; examining in great detail the nature of FUTY, its system boundaries and the interaction of the elements within it. It has also *taken pains* to structure and develop an integrated approach to addressing the multifarious issues which result in loss of data integrity, duplication of data, unreliability of information processes, and outright lack of an information policy in FUTY. It has taken essentially a soft systems outlook on the problem situations and utilised a wide range of OR tools and techniques. These techniques and tools were drawn from various areas including modelling, organisational behaviour, soft systems methodology, surveying, statistical analysis, queuing theory, and information systems. During the course of the work, the major emphasis shifted from mere logical appreciation of the problem situations to actual development of a plausible solution, hence, the development of a complete software suite, implementation heuristics, and redesigned organisational processes for FUTY. It is interesting to note that the study surveys revealed a very poor computer literacy profile amongst staff and students of FUTY. Among academic and management staff however, the information literacy profile was discovered to be high enough to sustain an integrated information delivery system.

## 5.3 MAJOR FINDINGS

The study was more of a problem solving and development work, and not a theoretical analysis of concepts. However, various issues of interest were uncovered during the course of the study. These include:

1. For the top management cadre, the study reveals that formal computer training is of critical importance in developing information systems literacy as well as computer literacy.
2. Top management of FUTY believe that the information systems in their offices are highly efficient in the following parameters; efficient utilisation of available resources, storage of existing records and data items, ability to retrieve stored data and records, and accuracy.
3. The correlation between information literacy and exposure to computers of top management of FUTY was evaluated at –0.3885 while that between information literacy and years of service was –0.1297. As such, it can be comfortably assumed that neither exposure to computing facilities nor years of service play any significant role in information literacy of that management cadre.
4. The information literacy profile of academic staff is reasonably high, with mean responses on all parameters ranging from 3.08 to 3.60 on a four-point Likert scale.
5. Correlation between information literacy and length of service of academic staff was –0.0212 while that between information literacy and exposure to computers was 0.1236. Hence, it becomes evident from details gathered from academic staff that these two parameters have little to do with the level of information literacy among this category of staff in FUTY.

6. The level of computer literacy of academic staff in FUTY is very low, with an index of 34.43%. However, considering the fact that almost all respondents showed familiarity with windows operations, this level of computer literacy may still be adequate to support the deployment of a system-wide information collection and dissemination system assuming proper training and documentation is made available.
7. With a variance of 2.33, the general thinking of academic staff is that a monthly charge of between ₦500.00 and ₦1,000.00 for unrestricted internet access in their offices would be acceptable.
8. With a variance of 2.33, the general thinking of FUTY students is that a semester charge of not more than ₦500.00 for unrestricted internet access in their departments would be acceptable.
9. The level of information literacy of both staff and students is adequate to support system-wide deployment of computer-based information systems. This, however, would only be achievable after training in the following areas is made available; database management, spreadsheet concept, and internet appreciation.
10. Though many staff and students pay lip service to the value of information in FUTY, this is not backed up with a willingness to make any significant expenditure on it with staff and students only being willing, on average, to part with ₦1000 monthly and ₦500 per semester respectively in this regard.

## 5.4 IMPLEMENTATION HEURISTICS

After careful examination of the major findings and the results of the various surveys carried out, it can be asserted that implementation of the new system should preferably be undertaken through the seven step process outlined below.

STEP 1: Reorganisation and strengthening of the MIS unit of the university. This should be done with a view of creating a special office for a network administrator who shall have responsibility over the entire university network.

STEP 2: Creation of a local area network (LAN) for the university making extensive use of wireless networking tools and concepts. A distributed star topology would be preferred for this as it would make it easier to mage the network, remove or add users (workstations) to the networks.

STEP 3: Deployment of wireless broadband internet access facilities.

STEP 4: Staff and student computer and internet appreciation training.

STEP 5: Provision of portable computers for the entire staff/student population of FUTY.

STEP 6: Installation of ALVIN on all computer systems.

STEP 7: Development of information policy for the entire university.

## 5.5 RECOMMENDATIONS

The following constitute the primary recommendations arrived at upon completion of this study:

### *5.5.1 Recommendations to FUTY*

This study developed a CBIS for FUTY. Naturally, it is strongly recommended that FUTY adopts the system in its entirety. This would require creating a system-wide Local Area Network (LAN) and installing the developed software

across the computer systems on the network. The full implementation heuristics outlined in section 5.4 of this study should be used as a yardstick in this regard.

### *5.5.2 Recommendations to Nigerian Higher Institutions*

Institutions of higher learning in Nigeria have a pivotal role in ensuring that OR/IT becomes a major driving force for national development. In this regard, the curricula for Management, Political Science, Physical and Applied Sciences, and Engineering should as a matter of principle contain ***significant*** OR/IT content. The Nigerian Universities Commission (NUC) and the National Board for Business and Technical Education (NBTE) as well as other important stakeholders would need to be consulted extensively in this regard.

### *5.5.3 Recommendations to Corporate Bodies in Nigeria*

It appears strange that profit-making organisations in Nigeria are yet to tap extensively into the awesome potentials in the fields of Operations Research and Information Technology. Accepted, there are still only very few tertiary institutions where the discipline is studied in Nigeria. However, a challenge is hereby given to corporate institutions in Nigeria to have a closer look into how they stand to benefit from absorbing the competencies of OR/IT in practice. Such organisations should earnestly consider the need to assist Government in equipping the OR/IT laboratories of these tertiary institutions and sponsoring deeper practical research in these fields.

### *5.5.4 Recommendations to the Nigerian Armed Forces*

The Nigerian military (in many ways still considered my constituency) has a Department of Operations at the top echelons of administration. However, to become more efficient by scales of magnitude, the many and multifarious capabilities of OR/IT should be extensively applied there. This study recommends that the Nigerian military seriously consider expanding the role of

the Department of Operations to include significant competence in OR/IT and possibly consider creating much stronger links with it and the Directorate of Army Data Processing (DADP) and equivalents across the armed services. The appointment of OR/IT-trained top military officers to head these Departments would be a plus. The possibility of sending out both civilian and military scientists for specialised training in OR/IT applications in the military should be explored. Such scientists can then be deployed to the Department and the Logistics units to form the nucleus of an *OR-savvy* military for enhanced efficiency. It should be remembered that OR started essentially as a military science, and developments in the field continue to serve the military in ways far more extensive than what is obtainable in most civilian settings. The Nigerian military should not be short-changed, but tap into this potential for developing a strong and highly efficient professional force.

### *5.5.5 Recommendations to the Federal Government of Nigeria*

It is the position of this study that the Nigerian government at all levels should, as a matter of urgency, attach great significance to OR/IT intervention studies in attempts to solve problems faced by government in the performance of its role. It is not sufficient to merely set up committees whose reports would be received later on and most likely just filed away for posterity. Rather, a more audacious approach, with OR/IT-trained scientists given a free hand to study the problem situations and participate in implementation of recommendations should be adopted. A national symposium on '*OR/IT in Practice*' may be required to facilitate this. Also, appointment of OR/IT-trained scientists to top-level advisory positions is highly recommended.

## 5.6 RECOMMENDATIONS FOR FURTHER STUDY

It is recommended that further studies should consider dissolving the messes experienced in various larger, more complex organisations in Nigeria. These should include; the Nigerian armed forces information delivery systems, the Nigerian Police force personnel deployment systems, corps member deployment systems for the Nigerian Youth Service Corps (NYSC), as well as allocation systems for facilities in organisations in underdeveloped societies.

## 5.7 CONCLUSION

During the period of preparing this study, it became imperative to question deeply the very fundamentals of the field which is today known as Operations Research. However, the nature of the study has reinforced certain concepts which propose to become key issues in the study of information systems development in developing countries in the near future. Of immense significance in this regard is the yet evolving concept of Data Envelopment Analysis (DEA).

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**APPENDIX I**

**DATA CAPTURE FORM Q/St/001**
**(QUESTIONNAIRE FOR STUDENTS)**

# FEDERAL UNIVERSITY OF TECHNOLOGY

**P. M. B. 2076, Yola**

## Department of Information Technology

**Survey Questionnaire FUTY/St/001.01**

Dear respondent,

I am an academic staff of FUTY in the Department of Information Technology presently working on the development of an Integrated Information Delivery System (IIDS) for a Nigerian University. I am using FUTY as a case. If successful, the research should culminate in the production of a software suite for automation of the major data capture and processing tasks in this institution.

In line with this, I need to elicit some information from various strata in the University community. The attached questionnaire is designed for students of FUTY, the stratum to which you belong.

I wish to hence request you to kindly spare a few minutes from your schedule to fill out the questionnaire as concisely as possible. Any item to which you *can not* or *will not* provide an answer may be *left blank*.

Do return the completed questionnaire through the person who handed it over to you. Alternatively, you may wish to leave the completed questionnaire with the Secretary to the Department of Information Technology to forward it to me.

Finally, let me assure you of the confidentiality of all data elicited from this survey. It shall be kept in strict confidence. Such data shall be used solely for academic purposes.

Thank you.

**Alvin O. FORTETA**
Department of Information Technology
Federal University of Technology, Yola

## SECTION A: Personal Data

***1.*** First Name: _____

***2.*** Department: _____

***3.*** Level: _____

***4.*** Indicate which of these positions you have ever occupied in FUTY

[ ] Department Association Official
[ ] SUG/SRC Official
[ ] Class Representative
[ ] Social/Religious group official
[ ] Others (please specify): _____

_____

***5.*** Academic qualification you have already obtained (tick all that apply):

[ ] O'Level Mathematics (at least at Credit level)
[ ] O'Level English (at least at Credit level)
[ ] A Level Certificate: _____
[ ] NCE (specify field): _____
[ ] ND (specify field): _____
[ ] HND (specify field): _____
[ ] First Degree (specify field): _____
[ ] Master's Degree (specify field): _____
[ ] Others (please specify): _____

_____

## SECTION B: Technical Details

***6.*** How many *functional* computers does your Department have?

[ ] Don't know
[ ] 0
[ ] 1 - 3
[ ] 4 - 6
[ ] 7 – 9
[ ] 10 or more

***7.*** Do you own a personal computer (PC or laptop)? [ ]Yes [ ]No

***8.*** Do you have regular access to a computer apart from those in the Department? [ ]Yes [ ]No

***9.*** Estimate the number of hours per week you spend making use of computers:

[ ] 0 - 4
[ ] 5 – 9
[ ] 10 – 14
[ ] 15 – 19
[ ] 20 or more

***10.*** If the University were to provide unrestricted internet access to you in your Department, what price range would you consider reasonable as a charge each session to you for it?

[ ] It should be free
[ ] Below ₦ 500.00
[ ] ₦ 500.00 – ₦ 1,000.00
[ ] ₦ 1,000.00 – ₦ 2,000.00
[ ] ₦ 2,000.00 – ₦ 3,000.00
[ ] Above ₦ 3,000.00

***11.*** On a scale of 0 – 5, rate your computer handling abilities for each of the following where: 0 = can not say, 1 = Poor, 2 = Fair, 3 = Good, 4 = Very good, and 5 = Excellent.

| | Parameters | *0* | *1* | *2* | *3* | *4* | *5* |
|---|---|---|---|---|---|---|---|
| ***a.*** | Spreadsheets | [ ] | [ ] | [ ] | [ ] | [ ] | [ ] |
| ***b.*** | Databases | [ ] | [ ] | [ ] | [ ] | [ ] | [ ] |
| ***c.*** | Word Processors | [ ] | [ ] | [ ] | [ ] | [ ] | [ ] |
| ***d.*** | Application software in your discipline | [ ] | [ ] | [ ] | [ ] | [ ] | [ ] |
| ***e.*** | Equation Editors | [ ] | [ ] | [ ] | [ ] | [ ] | [ ] |
| ***f.*** | Computer Hardware Maintenance | [ ] | [ ] | [ ] | [ ] | [ ] | [ ] |
| ***g.*** | Assembling Computers | [ ] | [ ] | [ ] | [ ] | [ ] | [ ] |
| ***h.*** | Website Design | [ ] | [ ] | [ ] | [ ] | [ ] | [ ] |
| ***i.*** | Computer Simulation | [ ] | [ ] | [ ] | [ ] | [ ] | [ ] |
| ***j.*** | Programming | [ ] | [ ] | [ ] | [ ] | [ ] | [ ] |

***12.*** On a scale of 0 – 4, rate the following statements, where: 0 = unable to assess, 1 = strongly disagreed, 2 = disagreed, 3 = agreed, and 4 = Strongly Agreed.

| | Parameters | *0* | *1* | *2* | *3* | *4* |
|---|---|---|---|---|---|---|
| ***1.*** | Computers should be used regularly for classroom instruction | [ ] | [ ] | [ ] | [ ] | [ ] |
| ***2.*** | Departments ought to be able to effectively use computers to produce student results and transcripts speedily | [ ] | [ ] | [ ] | [ ] | [ ] |
| ***3.*** | Departmental records ought to be kept on electronic databases | [ ] | [ ] | [ ] | [ ] | [ ] |
| ***4.*** | Student registration should be computerized | [ ] | [ ] | [ ] | [ ] | [ ] |
| ***5.*** | There is a need for unrestricted internet access for all students | [ ] | [ ] | [ ] | [ ] | [ ] |
| ***6.*** | The delays in acquiring information from sources within the University are unacceptably great | [ ] | [ ] | [ ] | [ ] | [ ] |
| ***7.*** | The delays in obtaining information-related services within the University are unacceptably great | [ ] | [ ] | [ ] | [ ] | [ ] |
| ***8.*** | Every student should have a computer allocated to him/her. | [ ] | [ ] | [ ] | [ ] | [ ] |

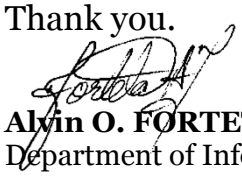
***13.*** State any other issue which you feel may be of significance in a study of this nature:

_____

_____

_____

Thank you.



**Alvin O. FORTETA**
Department of Information Technology
Federal University of Technology, Yola

**APPENDIX III**

**DATA CAPTURE FORM Q/Ac/002**
**(QUESTIONNAIRE FOR ACADEMIC STAFF)**

# FEDERAL UNIVERSITY OF TECHNOLOGY

**P. M. B. 2076, Yola**

## Department of Information Technology

**Survey Questionnaire FUTY/Ac/001.01**

Dear respondent,

I am an academic staff of FUTY in the Department of Information Technology presently working on the development of an Integrated Information Delivery System (IIDS) for a Nigerian University. I am using FUTY as a case. If successful, the research should culminate in the production of a software suite for full automation of the major data capture and processing tasks in this institution.

In line with this, I need to elicit some information from various strata in the University community. The attached questionnaire is designed for Academic staff of FUTY, the stratum to which you belong.

I wish to hence request you to kindly spare a few minutes from your tight schedule to fill out the questionnaire as concisely as possible. Any item to which you can not or will not provide an answer may be left blank.

Do find attached an envelope within which you may seal the completed questionnaire. This is to ensure confidentiality. You may wish to leave the completed questionnaire with your departmental secretary for me to retrieve.

Finally permit me pledge to keep all data elicited from this survey in strict confidence. Such data shall be used solely for academic purposes.

Thank you.

**Alvin O. FORTETA**
SP 822
Department of Information Technology
Federal University of Technology, Yola

## SECTION A: Personal Data

***1.*** First Name: _____

***2.*** Rank: _____

***3.*** Number of years you have worked in higher education: _____

***4.*** Indicate which of these positions you have ever occupied in FUTY
[ ] HOD
[ ] Exam Officer
[ ] Dean
[ ] Others (please specify): _____

_____

***5.*** Highest academic qualification obtained:
[ ] PhD

[ ] Master
[ ] Bachelor
[ ] Others (please specify): _____

_____

***6.*** Have you ever undergone formal computer training?
[ ] Yes
[ ] No

## SECTION B: Technical Details

***7.*** How many *functional* computers does your Department have?
[ ] Don't know
[ ] 0
[ ] 1 - 3
[ ] 4 - 6
[ ] 7 – 9
[ ] 10 or more

***8.*** Do you own a personal computer (PC or laptop)? [ ]Yes [ ]No

***9.*** Do you have regular access to a computer apart from those in the Department? [ ]Yes [ ]No

***10.*** Estimate the number of hours per week you spend making use of the Departmental computers:
[ ] 0 - 4
[ ] 5 – 9
[ ] 10 – 14
[ ] 15 – 19
[ ] 20 or more

***11.*** On a scale of 0 – 4, rate the following statements, where: 0 = unable to assess, 1 = strongly disagreed, 2 = disagreed, 3 = agreed, and 4 = Strongly Agreed.

| | Parameters | *0* | *1* | *2* | *3* | *4* |
|---|---|---|---|---|---|---|
| ***1.*** | Computers can be used to make work easier in the Department | [ ] | [ ] | [ ] | [ ] | [ ] |
| ***2.*** | Departments can effectively use computers to provide reports promptly | [ ] | [ ] | [ ] | [ ] | [ ] |
| ***3.*** | Departments can effectively use computers to produce transcripts as at when due | [ ] | [ ] | [ ] | [ ] | [ ] |
| ***4.*** | Departments can effectively use computers to provide students' results promptly for display on the notice board. | [ ] | [ ] | [ ] | [ ] | [ ] |
| ***5.*** | Departmental records ought to be kept on computer databases | [ ] | [ ] | [ ] | [ ] | [ ] |
| ***6.*** | Student registration should be computerized | [ ] | [ ] | [ ] | [ ] | [ ] |
| ***7.*** | There is a need for unrestricted internet access for all academic staff | [ ] | [ ] | [ ] | [ ] | [ ] |
| ***8.*** | The delays in acquiring information from sources within the University are unacceptably great | [ ] | [ ] | [ ] | [ ] | [ ] |
| ***9.*** | The delays in obtaining information-related services within the University are unacceptably great | [ ] | [ ] | [ ] | [ ] | [ ] |
| ***10.*** | Every academic staff should have a computer allocated to him/her. | [ ] | [ ] | [ ] | [ ] | [ ] |

***12.*** If the University were to provide unrestricted internet access to you in your office, what price range would you consider reasonable as a monthly charge to you for it?

[ ] It should be free
[ ] Below ₦ 500.00
[ ] ₦ 500.00 – ₦ 1,000.00
[ ] ₦ 1,000.00 – ₦ 2,000.00
[ ] ₦ 2,000.00 – ₦ 3,000.00
[ ] Above ₦ 3,000.00

***13.*** On a scale of 0 – 5, rate your computer handling abilities for each of the following where: 0 = can not say, 1 = Poor, 2 = Fair, 3 = Good, 4 = Very good, and 5 = Excellent.

| | Parameters | *0* | *1* | *2* | *3* | *4* | *5* |
|---|---|---|---|---|---|---|---|
| ***a.*** | Spreadsheets | [ ] | [ ] | [ ] | [ ] | [ ] | [ ] |
| ***b.*** | Databases | [ ] | [ ] | [ ] | [ ] | [ ] | [ ] |
| ***c.*** | Word Processors | [ ] | [ ] | [ ] | [ ] | [ ] | [ ] |
| ***d.*** | Application software in your discipline | [ ] | [ ] | [ ] | [ ] | [ ] | [ ] |
| ***e.*** | Equation Editors | [ ] | [ ] | [ ] | [ ] | [ ] | [ ] |
| ***f.*** | Computer Hardware Maintenance | [ ] | [ ] | [ ] | [ ] | [ ] | [ ] |
| ***g.*** | Assembling Computers | [ ] | [ ] | [ ] | [ ] | [ ] | [ ] |
| ***h.*** | Website Design | [ ] | [ ] | [ ] | [ ] | [ ] | [ ] |
| ***i.*** | Computer Simulation | [ ] | [ ] | [ ] | [ ] | [ ] | [ ] |
| ***j.*** | Programming | [ ] | [ ] | [ ] | [ ] | [ ] | [ ] |

***14.*** State the functions carried out by academic staff in your Department which you believe should be computerized: _____

_____

_____

***15.*** State any other issue which you feel is of significance in a study of this nature: _____

_____

_____

_____

**APPENDIX IV**

**DATA CAPTURE FORM M/001**
**(QUESTIONNAIRE FOR TOP MANAGEMENT)**

# FEDERAL UNIVERSITY OF TECHNOLOGY,
## P. M. B. 2076, YOLA
## Department of Information Technology

**The Vice Chancellor,**
Federal University of Technology,
P. M. B. 2076, Yola
Adamawa State

Sir,

**SURVEY OF FUTY TOP MANAGEMENT STAFF**

I am an academic staff of FUTY in the Department of Information Technology presently working on the development of an Integrated Information Delivery System (IIDS) for a Nigerian University. I am using FUTY as a case. If successful, the research should culminate in the production of a software suite for full automation of the major data capture and processing tasks in this institution.

In line with this, I need to elicit some information from various strata in the University community. The attached questionnaire is designed for Top Management of FUTY, the stratum to which you belong.

I wish to hence request you to kindly spare a few minutes from your tight schedule to fill out the questionnaire as concisely as possible. Any item to which you can not or will not provide an answer may be left blank.

Do find attached an envelope within which you may seal the completed questionnaire. This is to ensure confidentiality. You may wish to dispatch it to me at the Department of Information Technology, or leave the completed questionnaire with your secretary for me to retrieve.

Finally permit me pledge to keep all data elicited from this survey in strict confidence. Such data shall be used solely for academic and technical (software development) purposes.

Thank you.

**Alvin O. TORTETA**
***SP/822***

**Survey Questionnaire FUTY/M/001.01**

## SECTION A: Personal Data

**1.** First Name: _____

**2.** Number of years you have worked with FUTY: _____

**3.** Number of years you have worked in higher education (not FUTY): _____

**4.** Have you ever undergone formal computer training?

[ ] Yes
[ ] No
[ ] Not sure

## SECTION B: Technical Details

**5.** How many computers does your office possess?
[ ] None
[ ] 1 – 3
[ ] 4 – 6
[ ] 7 – 9
[ ] Above 9

**6.** Do you own a personal computer (PC or laptop)?
[ ] Yes
[ ] No

**7.** Do you have regular access to a PC apart from those in the office?
[ ] Yes
[ ] No

**8.** Estimate the number of hours per week you spend using the computer in the office:
[ ] 0 - 4
[ ] 5 – 9
[ ] 10 – 14
[ ] 15 – 19
[ ] 20 or more

**9.** How frequently do you visit the University (FUTY) web site?
[ ] Never
[ ] Occasionally
[ ] Monthly
[ ] Weekly
[ ] Daily

**10.** Please state the administrative functions carried out by staff in your office which you believe are amenable to computerization and should thus be automated:

*1.*_____

*2.*_____

*3.*_____

*4.*_____

*5.*_____

**11.** On a scale of 0 – 5, rate the present information delivery system in your office on the following parameters, where: 0 = Unable to assess, 1 = Poor, 2 = Fair, 3 = Good, 4 = Very good, and 5 = Excellent (Tick as appropriate).

| | Parameters | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|---|
| 1. | Efficient utilization of available resources. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **2.** | Storage of existing records and data items. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| **3.** | Ability to effectively retrieve stored data and records. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| **4.** | Ability to forecast future trends from existing data. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| **5.** | Accuracy of data and information-related services. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| **6.** | Cost-effectiveness of information-delivery function. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| **7.** | Speed and efficiency of data and information interchange between subunits. | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

**12.** State any other issue which you feel is of significance in a study of this nature: ___

_____

_____

_____

_____

_____

_____

_____

_____

_____

Thank you.

**Alvin O. FORTETA**
***SP. 822***

## APPENDIX V
## COEFFICIENT CORRELATIONS FOR ACADEMIC STAFF COMPUTER LITERACY PROFILE

| Model | | Programming | Internet | Word Processors | Equation Editors | Assembly | Web Design | Simulation | Spreadsheets | Databases | Apps in Discipline |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Correlations** | Programming | 1.000 | -.777 | .966 | .982 | .941 | -.895 | -.991 | -.977 | -.942 | -.966 |
| | Internet use | -.777 | 1.000 | -.757 | -.729 | -.706 | .677 | .741 | .776 | .705 | .754 |
| | Word Processors | .966 | -.757 | 1.000 | .916 | .978 | -.942 | -.934 | -.909 | -.979 | -1.000 |
| | Equation Editors | .982 | -.729 | .916 | 1.000 | .881 | -.813 | -.997 | -.990 | -.883 | -.915 |
| | Assembly | .941 | -.706 | .978 | .881 | 1.000 | -.974 | -.903 | -.858 | -1.000 | -.979 |
| | Web Design | -.895 | .677 | -.942 | -.813 | -.974 | 1.000 | .841 | .787 | .974 | .943 |
| | Simulation | -.991 | .741 | -.934 | -.997 | -.903 | .841 | 1.000 | .987 | .904 | .934 |
| | Spreadsheets | -.977 | .776 | -.909 | -.990 | -.858 | .787 | .987 | 1.000 | .858 | .908 |
| | Databases | -.942 | .705 | -.979 | -.883 | -1.000 | .974 | .904 | .858 | 1.000 | .979 |
| | Apps in Discipline | -.966 | .754 | -1.000 | -.915 | -.979 | .943 | .934 | .908 | .979 | 1.000 |

**Dependent Variable:** Computer Appreciation

## APPENDIX VI

## LIST OF ACRONYMS USED AND THEIR MEANING

| S. NO. | ACRONYM | MEANING |
|---|---|---|
| 1. | AI | Artificial Intelligence |
| 2. | ALVIN | Academic Locality Virtual Information Network |
| 3. | CBIS | Computer Based Information System |
| 4. | CBIS | Computer Based Information System |
| 5. | CTP | Cable Trench Problem |
| 6. | DAS | Direct Attached Storage |
| 7. | DSS | Decision Support System |
| 8. | EIS | Executive Information System |
| 9. | ES | Expert System |
| 10. | FGN | Federal Government of Nigeria |
| 11. | FUTY | Federal University of Technology, Yola |
| 12. | GDP | Gross Domestic Product |
| 13. | HBA | Host Bus Adapters |
| 14. | I/O | Input-Output |
| 15. | ICT | Information and Communications Technology |
| 16. | IDS | Information Delivery System |
| 17. | IIDS | Integrated Information Delivery System |
| 18. | IP | Internet Protocol |
| 19. | iSCSI | Internet Small-Scale Computer System Interface |
| 20. | IT | Information Technology |
| 21. | JAMB | Joint Admissions and Matriculation Board |
| 22. | LCG | Large Hadron Collider Computing Grid |
| 23. | MIS | Management Information System |
| 24. | NAS | Network Attached Storage |
| 25. | NUC | Nigerian Universities Commission |
| 26. | OR | Operations Research |
| 27. | ORS | Operations research Society |
| 28. | PC | Personal Computer |
| 29. | PIN | Personal Identification Number |
| 30. | RSD | Relational Systems Development |
| 31. | SAN | Storage Area Network |
| 32. | SATA | Serial ATA |
| 33. | SCSI | Small-Scale Computer System Interface |
| 34. | SCW | Scientific Computing World |
| 35. | SDLC | Systems Development Lifecycle |
| 36. | SIS | Strategic Information System |
| 37. | SONET/SDH | Synchronous Optical NETwork/Synchronous Digital Hierarchy |
| 38. | TCP/IP | Transmission Control Protocol/Internet Protocol |
| 39. | UME | Universities Matriculation Examination |
| 40. | USB | Universal System Bus |

## APPENDIX VII
## Welch's t-Test Computation/Results

### Academic Staff

| | Variable | $\bar{x}$ | $\sigma^2$ | $N$ | $t_1$ | $t_2$ | $df_1$ | $df_2$ | Table T |
|---|---|---|---|---|---|---|---|---|---|
| Y | Information Literacy | 3.375 | 1.07 | 40 | | | | | 0.9604 ***α=0.05*** |
| X1 | Computer Literacy | 2.066 | 3.37 | 40 | 3.929 | | 62 | | 0.9841 ***α=0.02*** |
| X2 | Fiscal Value of Internet | 2.17 | 2.33 | 40 | | 4.133 | | 69 | 0.9921 ***α=0.01*** |

### Students

| | Variable | $\bar{x}$ | $\sigma^2$ | $N$ | $t_1$ | $t_2$ | $df_1$ | $df_2$ | Table T |
|---|---|---|---|---|---|---|---|---|---|
| Y | Information Literacy | 3.093 | 1.324 | 200 | | | | | 0.9602 ***α=0.05*** |
| X1 | Computer Literacy | 1.422 | 1.986 | 200 | 12.989 | | 383 | | 0.9841 ***α=0.02*** |
| X2 | Exposure to computers | 0.56 | 0.25 | 200 | | 28.552 | | 272 | 0.9920 ***α=0.01*** |

## APPENDIX VIII
## Student's t-Table

| *1 Sided* | 75% | 80% | 85% | 90% | 95% | 97.5% | 99% | 99.5% | 99.75% | 99.9% | 99.95% |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *2 Sided* | 50% | 60% | 70% | 80% | 90% | 95% | 98% | 99% | 99.5% | 99.8% | 99.90% |
| **1** | *1* | *1.376* | *1.963* | *3.078* | *6.314* | *12.71* | *31.82* | *63.66* | *127.3* | *318.3* | *636.6* |
| **2** | *0.816* | *1.061* | *1.386* | *1.886* | *2.92* | *4.303* | *6.965* | *9.925* | *14.09* | *22.33* | *31.6* |
| **3** | *0.765* | *0.978* | *1.25* | *1.638* | *2.353* | *3.182* | *4.541* | *5.841* | *7.453* | *10.21* | *12.92* |
| **4** | *0.741* | *0.941* | *1.19* | *1.533* | *2.132* | *2.776* | *3.747* | *4.604* | *5.598* | *7.173* | *8.61* |
| **5** | *0.727* | *0.92* | *1.156* | *1.476* | *2.015* | *2.571* | *3.365* | *4.032* | *4.773* | *5.893* | *6.869* |
| **6** | *0.718* | *0.906* | *1.134* | *1.44* | *1.943* | *2.447* | *3.143* | *3.707* | *4.317* | *5.208* | *5.959* |
| **7** | *0.711* | *0.896* | *1.119* | *1.415* | *1.895* | *2.365* | *2.998* | *3.499* | *4.029* | *4.785* | *5.408* |
| **8** | *0.706* | *0.889* | *1.108* | *1.397* | *1.86* | *2.306* | *2.896* | *3.355* | *3.833* | *4.501* | *5.041* |
| **9** | *0.703* | *0.883* | *1.1* | *1.383* | *1.833* | *2.262* | *2.821* | *3.25* | *3.69* | *4.297* | *4.781* |
| **10** | *0.7* | *0.879* | *1.093* | *1.372* | *1.812* | *2.228* | *2.764* | *3.169* | *3.581* | *4.144* | *4.587* |
| **11** | *0.697* | *0.876* | *1.088* | *1.363* | *1.796* | *2.201* | *2.718* | *3.106* | *3.497* | *4.025* | *4.437* |
| **12** | *0.695* | *0.873* | *1.083* | *1.356* | *1.782* | *2.179* | *2.681* | *3.055* | *3.428* | *3.93* | *4.318* |
| **13** | *0.694* | *0.87* | *1.079* | *1.35* | *1.771* | *2.16* | *2.65* | *3.012* | *3.372* | *3.852* | *4.221* |
| **14** | *0.692* | *0.868* | *1.076* | *1.345* | *1.761* | *2.145* | *2.624* | *2.977* | *3.326* | *3.787* | *4.14* |
| **15** | *0.691* | *0.866* | *1.074* | *1.341* | *1.753* | *2.131* | *2.602* | *2.947* | *3.286* | *3.733* | *4.073* |
| **16** | *0.69* | *0.865* | *1.071* | *1.337* | *1.746* | *2.12* | *2.583* | *2.921* | *3.252* | *3.686* | *4.015* |
| **17** | *0.689* | *0.863* | *1.069* | *1.333* | *1.74* | *2.11* | *2.567* | *2.898* | *3.222* | *3.646* | *3.965* |
| **18** | *0.688* | *0.862* | *1.067* | *1.33* | *1.734* | *2.101* | *2.552* | *2.878* | *3.197* | *3.61* | *3.922* |
| **19** | *0.688* | *0.861* | *1.066* | *1.328* | *1.729* | *2.093* | *2.539* | *2.861* | *3.174* | *3.579* | *3.883* |
| **20** | *0.687* | *0.86* | *1.064* | *1.325* | *1.725* | *2.086* | *2.528* | *2.845* | *3.153* | *3.552* | *3.85* |
| **21** | *0.686* | *0.859* | *1.063* | *1.323* | *1.721* | *2.08* | *2.518* | *2.831* | *3.135* | *3.527* | *3.819* |
| **22** | *0.686* | *0.858* | *1.061* | *1.321* | *1.717* | *2.074* | *2.508* | *2.819* | *3.119* | *3.505* | *3.792* |
| **23** | *0.685* | *0.858* | *1.06* | *1.319* | *1.714* | *2.069* | *2.5* | *2.807* | *3.104* | *3.485* | *3.767* |
| **24** | *0.685* | *0.857* | *1.059* | *1.318* | *1.711* | *2.064* | *2.492* | *2.797* | *3.091* | *3.467* | *3.745* |
| **25** | *0.684* | *0.856* | *1.058* | *1.316* | *1.708* | *2.06* | *2.485* | *2.787* | *3.078* | *3.45* | *3.725* |
| **26** | *0.684* | *0.856* | *1.058* | *1.315* | *1.706* | *2.056* | *2.479* | *2.779* | *3.067* | *3.435* | *3.707* |
| **27** | *0.684* | *0.855* | *1.057* | *1.314* | *1.703* | *2.052* | *2.473* | *2.771* | *3.057* | *3.421* | *3.69* |
| **28** | *0.683* | *0.855* | *1.056* | *1.313* | *1.701* | *2.048* | *2.467* | *2.763* | *3.047* | *3.408* | *3.674* |
| **29** | *0.683* | *0.854* | *1.055* | *1.311* | *1.699* | *2.045* | *2.462* | *2.756* | *3.038* | *3.396* | *3.659* |
| **30** | *0.683* | *0.854* | *1.055* | *1.31* | *1.697* | *2.042* | *2.457* | *2.75* | *3.03* | *3.385* | *3.646* |
| **40** | *0.681* | *0.851* | *1.05* | *1.303* | *1.684* | *2.021* | *2.423* | *2.704* | *2.971* | *3.307* | *3.551* |
| **50** | *0.679* | *0.849* | *1.047* | *1.299* | *1.676* | *2.009* | *2.403* | *2.678* | *2.937* | *3.261* | *3.496* |
| **60** | *0.679* | *0.848* | *1.045* | *1.296* | *1.671* | *2* | *2.39* | *2.66* | *2.915* | *3.232* | *3.46* |
| **80** | *0.678* | *0.846* | *1.043* | *1.292* | *1.664* | *1.99* | *2.374* | *2.639* | *2.887* | *3.195* | *3.416* |
| **100** | *0.677* | *0.845* | *1.042* | *1.29* | *1.66* | *1.984* | *2.364* | *2.626* | *2.871* | *3.174* | *3.39* |
| **120** | *0.677* | *0.845* | *1.041* | *1.289* | *1.658* | *1.98* | *2.358* | *2.617* | *2.86* | *3.16* | *3.373* |
| **∞** | *0.674* | *0.842* | *1.036* | *1.282* | *1.645* | *1.96* | *2.326* | *2.576* | *2.807* | *3.09* | *3.291* |

## APPENDIX IX

## BARTLETT'S TEST COMPUTATION

where

### Top Management:

**DATA**

| S. No. | $N_i$ | $N_i - 1$ | $\frac{1}{(N_i-1)}$ | $\sigma_i^2$ | $\ln \sigma_i^2$ | $(N_i-1)\ln \sigma_i^2$ | $(N_i-1)\sigma_i^2$ | $\frac{(N_i-1)\sigma_i^2}{(N-k)}$ |
|---|---|---|---|---|---|---|---|---|
| **1** | 5 | 4 | 0.25 | 0.286 | -1.253 | -5.011 | 1.143 | 0.057 |
| **2** | 5 | 4 | 0.25 | 0.286 | -1.253 | -5.011 | 1.143 | 0.057 |
| **3** | 5 | 4 | 0.25 | 0.810 | -0.211 | -0.845 | 3.238 | 0.162 |
| **4** | 5 | 4 | 0.25 | 0.286 | -1.253 | -5.011 | 1.143 | 0.057 |
| **5** | 5 | 4 | 0.25 | 1.952 | 0.669 | 2.676 | 7.810 | 0.390 |
| **SUM** | **25** | **20** | **1.25** | **3.6190** | **-3.3005** | **-13.2022** | **14.4762** | **0.7238** |

| | |
|---|---|
| $N$ | ***25.00*** |
| $k$ | ***5.00*** |
| $k-1$ | ***4.00*** |
| $3(k-1)$ | ***12.00*** |
| $\frac{1}{3(k-1)}$ | ***0.08*** |
| $N-k$ | ***20.00*** |
| $\frac{1}{(N-k)}$ | ***0.05*** |
| $\sigma_p^2$ | ***0.72*** |
| $\ln \sigma_p^2$ | ***-0.32*** |
| $(N-k)\ln \sigma_p^2$ | ***-6.46*** |

Bartlett's test statistic: 6.1251

Chi$^2$ (0.05, 6): 0.2873

Decision: Reject $H_o$

Remark: We conclude that the variances of the groups of observations are not equal.

## Academic Staff

**DATA**

| S. No. | $N_i$ | $N_i - 1$ | $\frac{1}{(N_i - 1)}$ | $\sigma_i^2$ | $\ln \sigma_i^2$ | $(N_i - 1)\ln \sigma_i^2$ | $(N_i - 1)\sigma_i^2$ | $\frac{(N_i - 1)\sigma_i^2}{(N - k)}$ |
|---|---|---|---|---|---|---|---|---|
| **1** | 40 | 39 | 0.0256 | 9.074 | 2.205 | 86.013 | 353.900 | 0.825 |
| **2** | 40 | 39 | 0.0256 | 1.477 | 0.390 | 15.208 | 57.600 | 0.134 |
| **3** | 40 | 39 | 0.0256 | 1.071 | 0.069 | 2.681 | 41.775 | 0.097 |
| **4** | 40 | 39 | 0.0256 | 1.477 | 0.390 | 15.208 | 57.600 | 0.134 |
| **5** | 40 | 39 | 0.0256 | 1.456 | 0.376 | 14.646 | 56.775 | 0.132 |
| **6** | 40 | 39 | 0.0256 | 0.862 | -0.149 | -5.812 | 33.600 | 0.078 |
| **7** | 40 | 39 | 0.0256 | 0.922 | -0.081 | -3.170 | 35.955 | 0.084 |
| **8** | 40 | 39 | 0.0256 | 1.112 | 0.106 | 4.147 | 43.375 | 0.101 |
| **9** | 40 | 39 | 0.0256 | 0.635 | -0.454 | -17.695 | 24.775 | 0.058 |
| **10** | 40 | 39 | 0.0256 | 0.600 | -0.511 | -19.922 | 23.400 | 0.055 |
| **11** | 40 | 39 | 0.0256 | 1.077 | 0.074 | 2.890 | 42.000 | 0.098 |
| **SUM** | **440** | **429** | **0.282** | **19.7629** | **2.4152** | **94.1925** | **770.7550** | **1.7966** |

| | |
|---|---|
| $N$ | **440.00** |
| $k$ | **11.00** |
| $k - 1$ | **10.00** |
| $3(k - 1)$ | **30.00** |
| $\frac{1}{3(k - 1)}$ | **0.03** |
| $N - k$ | **429.00** |
| $\frac{1}{(N - k)}$ | **0.0023** |
| $\sigma_p^2$ | **1.80** |
| $\ln \sigma_p^2$ | **0.59** |
| $(N - k)\ln \sigma_p^2$ | **251.36** |

Bartlett's test statistic: 155.7126

Chi² (0.05, 6): 0.8912

Decision: Reject $H_0$

Remark: We conclude that the variances of the groups of observations are not equal.

**Students**

**DATA**

| S. No. | $N_i$ | $N_i - 1$ | $\frac{1}{(N_i - 1)}$ | $\sigma_i^2$ | $\ln \sigma_i^2$ | $(N_i - 1) \ln \sigma_i^2$ | $(N_i - 1)\sigma_i^2$ | $\frac{(N_i - 1)\sigma_i^2}{(N - k)}$ |
|---|---|---|---|---|---|---|---|---|
| **1** | 200 | 199 | 0.005 | 2.136 | 0.759 | 151.071 | 425.155 | 0.214 |
| **2** | 200 | 199 | 0.005 | 1.829 | 0.604 | 120.166 | 364.000 | 0.183 |
| **3** | 200 | 199 | 0.005 | 2.888 | 1.061 | 211.076 | 574.780 | 0.289 |
| **4** | 200 | 199 | 0.005 | 2.472 | 0.905 | 180.097 | 491.920 | 0.247 |
| **5** | 200 | 199 | 0.005 | 1.632 | 0.490 | 97.488 | 324.795 | 0.163 |
| **6** | 200 | 199 | 0.005 | 2.391 | 0.872 | 173.498 | 475.875 | 0.239 |
| **7** | 200 | 199 | 0.005 | 1.507 | 0.410 | 81.602 | 299.875 | 0.151 |
| **8** | 200 | 199 | 0.005 | 1.988 | 0.687 | 136.692 | 395.520 | 0.199 |
| **9** | 200 | 199 | 0.005 | 1.169 | 0.157 | 31.150 | 232.720 | 0.117 |
| **10** | 200 | 199 | 0.005 | 1.839 | 0.609 | 121.256 | 366.000 | 0.184 |
| **SUM** | **2000** | **1990** | **0.050251** | **19.8525** | **6.5532** | **1304.0965** | **3950.6400** | **1.9852** |

| | |
|---|---|
| $N$ | ***2000.00*** |
| $k$ | ***10.00*** |
| $k - 1$ | ***9.00*** |
| $3(k - 1)$ | ***27.00*** |
| $\frac{1}{3(k - 1)}$ | ***0.04*** |
| $N - k$ | ***1990.00*** |
| $\frac{1}{(N - k)}$ | ***0.0005*** |
| $\sigma_p^2$ | ***1.99*** |
| $\ln \sigma_p^2$ | ***0.69*** |
| $(N - k) \ln \sigma_p^2$ | ***1364.63*** |

Bartlett's test statistic: 60.4206

Chi² (0.05, 6): 0.8343

Decision: Reject $H_0$

Remark: We conclude that the variances of the groups of observations are not equal.

## APPENDIX X

## END NOTES

[1] Latin: Who guards the Guardians

[2] German: Misconceptions

[3] Latin: At the point of death

[4] German: Worldview