KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY, KUMASI, GHANA

COLLEGE OF SCIENCE

DEPARTMENT OF MATHEMATICS

"AN ORDINAL REGRESSION ANALYSIS OF STUDENTS' SATISFACTION; A CASE STUDY OF THE COLLEGE OF SCIENCE IN KNUST".

BY

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MAY, 2013

AN ORDINAL REGRESSION ANALYSIS OF STUDENTS' SATISFACTION; A CASE OF THE COLLEGE OF SCIENCE IN KNUST

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DECLARATION

I, Michael Ekow Quansah hereby declare that this study "An Ordinal Regression Analysis of Students' Satisfaction; A Case of the College of Science In KNUST" was undertaken by me under supervision and that to the best of my knowledge, it contains no material previously published by another person nor material which has been accepted for the award of any other degree of the university, except for references from other sources, which have been duly acknowledged.

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(Head of Department)	Signature	Date

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Finally, I am grateful to my parents, siblings, friends and loved ones for their encouragements, prayers and support in diverse ways, God richly bless them all.

DEDICATION

I dedicate this thesis to my Lord Jesus, for in the porter's hands He makes something out of nothing. Thank you, Father for your faithfulness, grace and mercy.

I humbly dedicate this work to my parents and friends for their immense support, especially to Mr. Edward Acheampong and my supervisor; Nana Kena Frempong.

ABSTRACT

For the purposes of understanding student priorities and satisfaction concerns, ordinal logistic regression analysis was used to analyze responses from 644 students of the College of Science in KNUST, by administering questionnaires to the stratified population. Students' satisfaction with their "college experience" was expressed as a function of gender, year of study and department on a five point Likert scale. Out of the five response categories, it was concluded that "satisfied" had the highest probability of being selected by a student.

Exceptions to this generalization came from the physics and optometry students. Gender and department were independent of student satisfaction based on satisfaction with respect to the "college experience". The research concluded that the length of exposure to the "college experience" was the most significant determinant of student satisfaction. That is, the opinion of seniors (year three and four) in the college of science should necessarily be sought and given more weight during evaluation. Proportional odds assumption was used to model the relationship between the dependent and explanatory variables.

TABLE OF CONTENT

LIST OF ACRONYMS

BZU	Bahaudin Zakariya University
CMH	Cochran-Mentel-Haenzel
POA	Proportional odds assumption
WEI	Work Environment Index
SERVQUAL	Service Quality
KNUST	Kwame Nkrumah University Of Science And Technology

LIST OF TABLES

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Student satisfaction is defined differently by researchers from different perspectives. Some researchers summarize student satisfaction into three views based on overviews of former research. Student satisfaction has been defined based on a students' mental experience, students' feedback on the education services offered by university and by their comparisons between their ideal college or university and the reality (WEI Wei, 2008). In my view, student satisfaction is actually the perception and valuation of every service offered by the university based on their internal expectation. The influencing factors of student satisfaction are comprehensive. However, the various definitions of student satisfaction do have some form of conceptual convergence.

Tracking student satisfaction and the priorities of students are important tasks for many university campuses the world over especially in these challenging times where economic resources cannot afford to be spent loosely. Increased competition, a dynamic educational environment, challenges such as budget cuts, higher costs of obtaining college education, changing demographics in the population, and a general public call for accountability have made educational institutions realize the importance of ~~student~~ satisfaction (Cheng and Tam, 1997; Kotler and Fox, 1995). Based on theories from consumer behavior and social behavior, when campuses understand the priorities of their students, resources can be used efficiently and effectively to satisfy students.

According to some researchers (Henning-Thurau et al., 2001) institutions of higher education could greatly benefit from being able to establish lasting relations with their students. Studies have shown student satisfaction to have a positive impact on student motivation, student retention, recruiting efforts and fundraising (Borden, 1995).

Students' satisfaction is a key component of student life and learning, a gauge of whether an institution is providing an experience that students deem worthwhile. The students' positive feeling and satisfaction is contingent upon the students' academic and social experiences obtained at a particular institution (Aitken, 1982).

Students like any human seek accomplishment, gratification, importance and compensation for every single endeavour they undertake as rational human beings. Being able to identify and address students' needs and expectations allows educational institutions to attract and retain quality students as well as improve the quality of their programs (Elliott and Shin, 2002). Students prioritize, make choices and make deliberate efforts to reduce pain and discomfort, so the findings of this research will help students a lot.

Clearly, every student is prone to experience this dissatisfaction by some margin of finite probability. For the purposes of this research, we would be interested in the matters of ~~interest to~~ students of KNUST. A students' level of satisfaction or dissatisfaction with the current system and structure as it is presented to students.

Since the absence of satisfaction within a student can have baneful consequences for both the university and the student (Popli, 2005). It could cause bad student performance, make students to quit or transfer (Chadwick and Ward, 1987) and have negative word-of-mouth influence that might damage future applications.

In general terms, dimensions already found in various studies about satisfaction, applied to the higher education sector, are in line with the four generic dimensions referred by (Garland and Westbrook,1989) to assessments of satisfaction in non-profitable services, namely: service policy, the supplier, the surrounding social environment, and the surrounding physical environment, with superior importance given to interpersonal dimensions. The collated responses of students will be analyzed with the deftness of mathematics.

This research covers the whole educational product, as well as the way it is served to students. These dimensions are; the proper student, such as the performance level (although this can be influenced by several factors); the value of the educational experience in future terms (quality of teaching, preparation for working life, academic reputation, etc.); the surrounding environment provided by the university (integration, relationship with others, events, etc.); the lecturers (interaction, efficiency in teaching, etc) and the interest in the student as a person (advice, interest in solving their problems, etc).

1.2 Problem statement

Is there evidence of dissatisfied or satisfied students in the college of Science? This knowledge or ~~the lack of~~ it about the college of science students' satisfaction issues may be a latent factor in some responses faculty and the administration get from their students. If truly there are lapses in the knowledge of KNUST students' satisfaction concerns, then now more than ever is the time to highlight these concerns and act on them.

As an institute of higher education, the college of science, KNUST cannot hide from the fact that it owes itself the duty of being educated on all fronts especially on local issues; meaning issues that can be resolved with little or no external influence. One such issue is KNUST's knowledge of the level of satisfaction of our own students; the only customers and the very reasons why the faculty and administrative staff keep coming back to this university campus.

What does this lack of knowledge cost the college of science, KNUST, as a university? Could the college of science, KNUST, do better if it knew everything there was to know about its students' levels of satisfaction? Who benefits from this knowledge and who suffers from this knowledge? What is the degree of our interest in KNUST students and their veridical concerns? It is safe to say that the solution lies in the knowledge of what exactly is missing or what has been adjusted wrongly. Just the knowledge will be an initial solution to the loathing of students in KNUST.

1.3 Objectives of the Study

1. Find the marginal contributions of the variables that determine student satisfaction.
2. To fit an ordinal logistic regression model on the satisfaction data.

1.4 Justification of the Study

According to the core values of KNUST (to provide an environment for teaching, research and entrepreneurship training in Science and Technology for the industrial and socio-economic development of Ghana, Africa and the world at large) can be achieved only when the students work in tandem with policy makers. By sharing experiences and working on the policies, services and structures that need improvement.

With the college of science, KNUST, listening to its students, the progress toward campus goals would not be such an arduous task. This is because the parts of the college experience that yield low satisfaction would have been exposed and hence policy makers would know how to address issues of that nature in future.

This project will give policy makers the needed information to embark on the necessary projects to help increase general student satisfaction levels as well as meet a lot of the universities goals and objectives. Again, it can serve as a monitor for studying new developments in students' satisfaction for the college of science, KNUST over time. This way, previous results can be compared with current ones to determine progress toward achieving an ideal university.

The conclusions of this project would show the factors that influence the college experience such that students frequently or rarely report high satisfaction with the college experience. Also, we would be able to define satisfaction in the language of a student and then know what a said student's scale of preference looks like. This refined understanding of what a student's satisfaction is would inform policy makers on what to adjust, eliminate or improve upon.

1.5 Methodology of the Study

Primary data was collected from the college of science students using a designed questionnaire. The method of ordinal logistic regression analysis was used to analyze the data to find the effect of gender, level (length of exposure to the college experience) and department on determining the level of satisfaction among students using Statistical Analysis System (SAS) version 9.

1.6 Limitations of the Study

(i) Responses are based on self reported information which mostly is subject to biases.

(ii) The time frame within which the research was to be carried out was too short.

(iii) Books and Scientific Journals were very expensive and difficult to access.

1.7 Organization of the Study

The thesis consists of five chapters. Chapter one covers the introduction, problem statement, objectives of the study, justification, methodology and structure of the thesis. Chapter two reviews literature related to the study; where many papers related to the subject of student satisfaction are perused, compared and contrasted with each other. Chapter three contains the method used to carry out this research. Chapter four presents data collection and analysis; Chapter five, focuses on the conclusions and recommendations of the study.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

For the purposes of improving student services and opportunities, many authors have researched into the subject of student satisfaction. Individual authors focused on specific portions of the problem. Several mathematical methods have also been employed to study student satisfaction. This chapter presents a review (perusal, comparison and contrast) of some of the papers that have measured student satisfaction and the conclusions they reached. The method of data collection is almost the same for all these authors.

2.2 Review of literature

To establish long-term relationships with their students, higher education institutions need above all to satisfy them. Although to find their students' satisfaction level they need to find effective ways to measure it. The study of (Alves and Raposo 2009,) presented a way to measure the construct "satisfaction in higher education" through the use of structural equations. Their results showed that the construct satisfaction, when measured through the variables used presented a reliability coefficient of 93%. Advising system, general teaching quality, market value of the degree, academic–social life among others were the variables used in their research. Their paper sought to examine the relationship between perceived services delivered that influenced student satisfaction. Particular attention had been given to the education sector because of its increasing importance. "For educational institutions to provide better service there should be some competitive advantage for students", they said. Their research was conducted among students of Private colleges of Penang, Malaysia.

Students were chosen as respondents in order to look at student's satisfaction on the education service delivery from student's point of view.

Husain et al (2009) found that physical environment, interaction and support, feedback and assessment, and administration were strong factors which result in students' satisfaction. Their paper was helpful in enabling private colleges and education sector managers to identify the key education service quality factors from the students' perspective. They posited that the concept of education service delivery and its impacts on students' satisfaction in colleges is a relatively new concept among Malaysian private colleges and there is a lack of previous studies using SERVQUAL (service quality) or similar methodologies in assessing students' satisfaction based on the education service delivery of private colleges. Therefore, the research findings can be used by private colleges in enhancing the quality of their education service delivery to their students.

Another study to determine the satisfaction levels of existing master's students attending a two-week summer session towards the same master's program in education with specializations in career and human resources education. Increased competition, dynamic educational environment, challenges such as budget cuts, higher costs in obtaining college education, changing demographics in the population, declining enrollments, and a general public call for accountability had made educational institutions realize the importance of student satisfaction (Cheng and Tam, 1997; Kotler and Fox, 1995). A survey design was utilized to carry out their study. (Sum et al, 1994) found that the majority of the students were either satisfied or extremely satisfied with the department's master's program.

(Denson et al, 2010) said the main goals of course evaluations were to obtain student feedback regarding courses and teaching for improvement purposes and to provide a defined and practical process to ensure that actions were taken to improve courses and teaching. Of the items on course evaluation forms, the one that received the most attention and consequently the most weight is the question, "Overall, I was satisfied with the quality of this course". However, no premium had been placed on examining the predictors of students being 'satisfied with the quality of this course' overall. Their study attempted to address this gap. Their findings showed that while student characteristics and reasons for enrolling in a course were predictors of overall satisfaction, it was the evaluation questions that predicted the majority of the variation in course satisfaction. Their findings also revealed that faculty-selected optional questions were stronger predictors of overall satisfaction than compulsory questions.

(Sumaedi et al, 2011) researched into the effects of students' perception of quality and satisfaction and the price they put on the two characteristics in the context of their academic experience. Their research sourced the responses of 155 students from two Indonesian public universities and used multiple regression analysis to analyze the responses. Their research results showed that students' perceived quality and perceived price ~~have~~ positive influence on the students' satisfaction. Besides that, students' perceived quality is affected more by student satisfaction than perceived price.

(Gibson, 2010) observed that many studies have examined the reasons for students' satisfaction or dissatisfaction with their higher educational experience. However, no single paper reviewed the major attributes of an educational program that were most commonly found to be significant predictors of student satisfaction. His paper reviewed the major attributes that most influenced students' perceptions of overall satisfaction with particular emphasis on business students' satisfaction'. He concluded that academic factors such as the quality of teaching, skills and knowledge acquired and the curriculum itself are the most significant determinants of overall satisfaction.

A number of other non-academic factors, however, such as the student's feeling of 'belonging' and perceptions of the institution's responsiveness and concern, also contribute significantly to overall satisfaction. He cited several works that reiterated his conclusions. His paper was intended as a starting point for those who may be designing a student satisfaction survey or those who simply wish to learn about the attributes of an academic program most likely to influence students' opinion of the program. He added that there were several areas that needed further studies namely; the predictors should be validated and refined if necessary and the relative importance of each determined. He intimated that the results and conclusions reached may also vary according to type of student body, institution etc. "The importance of 'reputation' as a predictor and how best to measure and determine its impact would also be of interest in further research. Likewise, the importance of pre-enrolment factors needed further study together with recommendations for how best to estimate their ~~impact on~~ overall satisfaction", Gibson suggested.

Kotler et al.(2009) defined satisfaction as 'a person's feeling of pleasure that resulted from comparing a product's perceived performance (or outcome) to their expectation. Based on this definition by Kotler et al. (2009), Abbasi and Malik (2011) made a study which measured the level of student satisfaction with current services offered by Pakistani universities. The exploration and comparison of possible differences in terms of level of satisfaction across gender and various programs/disciplines were the key objectives. 401 students were sampled. Bahauddin Zakariya University (BZU) was been selected as sample case and data was collected from eighteen different disciplines and/or programs. Ten major constructs (teaching, administrative/management support, transportation, library, computer labs and general labs, accommodation, medical, sports, prayer/religious facilities, and class room facilities) were used. Mean analysis reflected that students were dissatisfied with many core services and facilities like teaching, administrative support, library, labs, accommodation, medical, and sports, while satisfaction was reported only in three augmented areas like transportation, class room and prayer facilities. All variables were measured on Likert Scale. Interestingly, no significant differences of opinion were recorded among male or female respondents. Overall, satisfaction level is alarmingly low and results indicate dissatisfaction of university students on educational services offered by Pakistani universities. This gives credence to Gibson's (2010) accession that the results and conclusions reached may also vary according to type of student body, institution etc. They said the current situation needs the attention of all the educational authorities (Ministry of Education Government of Pakistan, Higher Education Commission of Pakistan, Chancellors of both Public and ~~Private~~ universities, Vice Chancellors and Rectors, concerned Deans, and everyone responsible) to enhance the quality and standards of higher education in the country.

Student satisfaction has been widely recognized as an indicator of the quality of the students' learning and teaching experience. The aim of the study was to explore the extent to which student satisfaction is influenced by 13 demographic- and educational-related variables. A cross-sectional survey was undertaken (18-item questionnaire, 1660 questionnaires). Principal component analysis categorized the 18 items into four learning and teaching dimensions. Each of the 13 variables was analysed for its influence on student satisfaction generally and on the four dimensions individually, before and after controlling for all the other variables. After controlling for all the variables, none of the demographic characteristics was associated with satisfaction. Most of the educational variables exercised their own independent and significant effects on general satisfaction and on satisfaction with the four individual dimensions. Collectively, decreased satisfaction was associated with being a pre registration, full-time student, usually with A level entry qualifications, attending term two modules whose assessment/s comprised combined strategies. Decreased satisfaction was also significantly associated with larger class sizes as regards the student numbers and with attaining lower grades in the assessments. The demographic variables were not as influential as the educational ones with respect to student satisfaction. The implications of the findings for research and practice were discussed.

A research with a theme that attempted to find out the factors that affect students' satisfaction in higher learning institutions was staged in Malaysia. The students were randomly selected ~~from~~ various categories to evaluate the level of students' satisfaction. The primary data source was a questionnaire that was distributed to the students. Four factors were chosen as independent variables namely; gender, race, student status and CGPA. The study showed that the overall services offered by the university were moderate from the students' perspective. Findings showed that the academic-related activities were more important than non academic-related such as the availability of financial advice etc. It was inferred from the findings that the academic activities should not be limited to classroom activities only. It must cover everything that can develop and instill good values, attitude, character and strong personality. In order to attain new students and retain current students they should aim to enhance student satisfaction and reduce student dissatisfaction. This can only be achieved if all services that are related to academic life such as implicit services, explicit services and physical services are delivered to a suitable standard. (Jalali et al, 2010) intimated the importance for service providers to gradually improve the quality and allocate resources accordingly. Also, owing to resource restrictions, rules, regulation, as well as policies, in some instances it is almost impossible for public universities to provide everything that students would want. They suggested that future research should focus on the perception of service quality from other stakeholders (such as internal customer, government, industries, etc.). A comprehensive study would help the faculty to review and buff up its overall service quality in the education sector.

Student satisfaction, as a means for improving educational management and the interaction between students and colleges, has drawn increasing attention among colleges and universities in China. A paper aimed at strategic managerial adjustments in terms of continuing education in Guangzhou University and promoting development ~~for~~ both students and the university so as to offer quality academic programs to students, analyzed characteristics of student satisfaction and discussed the inner links of workplace attitudes, major correlation between and among academic assistance, attendance, and satisfaction based on randomly selected data on the satisfaction of 480 in-service students in the School of Continuing Education in Guangzhou University.

The results indicated: unsatisfactory factors were mainly manifested in the lack of learning systems conforming to adult characteristics, and the lack of teaching and teaching environments conforming to the modes of adult education, and academic assistance is the key factor that influences students' attendance and satisfaction. Therefore, they recommended that top priority should be given to establishing learning systems conforming to adult characteristics, exploring teaching that can reflect the modes of adult education, and building teaching environments conforming to adult learning in the management of adult higher education, Furthermore, the key to improved student learning initiatives and satisfaction lies in enhancing the practicability and pertinence of academic courses, as well as strengthening practical teaching (Guosheng et al., 2010).

(Kotler et al., 2009) defined satisfaction as "a person's feeling of pleasure that result from comparing a product's perceived performance (or outcome) to their expectation". It means if the performance matches the expectation, the customer will be satisfied. In the context of higher education, the matter of satisfaction is what students expect from their educational institution, in fact, everything that makes them eligible to become productive and successful persons in their practical lives.

(Reid, 2008) had classified a few basic characteristics that employers normally sought from university graduates. These included knowledge, intellectual abilities and ability to work in modern organizations, interpersonal skills, and communication skills. In addition, there are other invisible characteristics required by the market and that include: willingness to learn, be participative and positive to work in teams, problem solving skills, analytical abilities, leadership qualities, adaptability, flexibility, ability to summarize key issues, and last but not least the ability to be productive and loyal team/organizational member. The attainment of these skills and abilities is what parents expect when they decide to send their children for higher education in universities.

The question under consideration here is if university graduates are provided necessary facilities and events that make their experience conducive and attainment of necessary skills and abilities possible. This is crucial not only to students' individual success but the success of economy of the country on the whole as well. In this regard, (Umbach and Porter, 2002) argued that institutional impact on the students' outcome is still unknown, and if anything is known, that is somewhat contradictory. Moreover, it is worth mentioning that different academic disciplines vary in terms of their application of practical problems, cognitive processes, faculty time commitment and scholarly output. Hence, it is quite difficult to conclude institutional impact on students' outcome. However, among the earlier researchers, (Cameron and Ettington, 1988) and (Hartnett and Centra, 1977) measured the impact of departmental culture and climate on students' leaning and satisfaction.

Much of the current knowledge on student satisfaction can be traced from studies during a period of unrest in the late 1960s and early 1970s (Betz et al., 1970). Interestingly, the focus of these early studies was the level of satisfaction as opposed to cause of satisfaction (Bean and Bradley, 1986). In literature, there exists an interesting debate suggesting that students' expectation build prior to enrolment in a college or university, while satisfaction exists during his/her stay in college or university. For example, (Palacio et al., 2002) suggest that student expectation normally build even before entering the university. The image of an institution affects students' mindset that in turn affects their decision to enroll in that particular institution that later on directly affects students' satisfaction with the institution.

However, (Carey et al., 2002) stressed that satisfaction actually covers issues of students' perception and experiences during their academic years. This has been supported by (Kara, 2004) who employed empirical data and conceptual model to prove that students' college experience is positively related to their satisfaction and intentions to stay at college or university.

Earlier, (Keaveney and Clifford, 1997) have presented students satisfaction and retention model. According to this model, faculty, advising staff and class room facilities normally shape student practical college experience and therefore considered key satisfaction and retention components.

Researchers have also measured students' satisfaction in context of many tangible and intangible elements and characteristics, for example, (Feldman and Newcomb, 1969) and (Pascarella and Terenzini, 1991) have explored relationship between student learning experiences and their learning, development and satisfaction. (Pike, 1994) have suggested alumni satisfaction as an excellent tool for assessing the effects of educational institution on students. Based on the studies of (Pascarella and Terenzini, 1991) and (Umbach and Porter, 2002), it is stated that intellectual and personal developments are among the key satisfaction outcomes of educational institutions. Moreover, they found variables like faculty contact with students, research emphasis, and proportion of female students had significant impact on student satisfaction. (Ewell, 1989) has observed negative correlation between institutional culture and its impact on student performance.

The contradiction exits in literature regarding the relationship between grades and students satisfaction. Authors like (Liu and Jung, 1980) and (Pike, 1991) have observed moderate relationship, while (Bean and Bradley, 1986) found no relationship at all. However, (Centra and Rock, 1983) and (Lavin, 1965) observed a significant relationship between grades and student satisfaction. On the other hand, limited attempts have been made to measure impact of gender, ethnicity, race, religion and migrations from one educational institution to another, on student satisfaction. However, existing evidence reports less satisfaction among female students as compared to male students (Rienzi et al., 1993).

Numerous studies have addressed the issue of service quality and student satisfaction. For example, (Fitri et al., 2008) have observed service quality dimension (tangibility, responsiveness, reliability, assurance, and empathy) as positive contributors towards student satisfaction. Some other authors like (Bigne et al., 2003), (Ham and Hayduk, 2003) and (Elliot and Shin, 2002) have reported significant relationship between service quality (service reliability, responsiveness, empathy, assurance, tangibility etc) and satisfaction in higher education settings. (Spreng and Mackoy, 1996) reported that perceived service quality is an antecedent to satisfaction.

Faculty continues to be the most significant influence on student experience and satisfaction in universities. In this regard, universities have adopted student evaluation of teaching effectiveness to enhance student satisfaction. Student evaluation of teaching (SET) is among the most frequently used performance measurement instruments used by higher education institutions across the world (Pounder, 2007; Stratton, 1990). Student evaluation of teaching (SET) questionnaire is a control device used to measure teaching effectiveness as stated by concerned students (Crumbley et al., 2001).

Historically, a number of studies confirmed that student teaching evaluation has provided reasonably valid multidimensional measures (Holtfreter, 1991; McKeachie, 1987). The main aim of the SET is to measure the teaching performance/effectiveness of faculties at a university. Moreover, this technique is used in educational institutions to assess the capabilities and competencies of academic staff and as a result, assessment score depicts that on what basis students perceive their teachers in their minds that directly affects their satisfaction.

In context of Pakistan, majority of the studies have focused on the ways to improve the quality of higher education, unfortunately, no significant study has probed the issue of student satisfaction. For example, (Hanif et al., 2008) examine the use of balance scorecard to enhance accountability and performance in higher education institutions concluding that long-term vision through consistent performance evaluation is the key to enhance performance in higher education. (Reid, 2008), while making comparison between higher education in Scotland and Pakistan, highlighted industry as a source of evaluation parallel to internal evaluation system. Moreover, he suggested an increase in the number of PhD qualified teachers throughout the country. (Owais and Akber, 2008) commented how to improve research/PhD education in the country.

From the existing literature, it is evident that there is a need to administer a systematic research to measure the important issue of student satisfaction in Pakistani universities. From literature, three different constructs (teaching, administration/management, and support and augmented facilities) have been used as major variables to measure student satisfaction in this study.

Another study examined the effects of faculty incivility on nursing students' satisfaction with their nursing programs, a topic previously unreported. In addition, incidences of incivility, students' responses to incivility, and academic location of incivility were explored. A high incidence of perceived faculty incivility was reported by participants, and perceived incivility correlated strongly with nursing student program dissatisfaction. Possible causes of incivility in academia and suggestions for addressing this problem were discussed by (Marchiondo and Lasiter, 2010).

The purpose of their study was to investigate characteristics of learning environments to explore the students' satisfaction level. Questionnaires were the instrument used to collate the relationship between the variables such as Student satisfaction (dependent variable) and the following predictor variables: Course work, teaching methods, Learning resources, Learning environment, Informal association, Work assessment. The study found that student satisfaction in English language course was positively affected by all independent variables that were described above. The results were confirmed by linear regression in SPSS (14.0). Survey techniques were used and data collected from different universities situated in the capital of Pakistan. The sample size was limited and only considers Pakistan's capital as a sampling ~~area.~~ Conclusions drawn were helpful for academic institutions and also for the students (Khalid and Ur Rehman, 2010).

Student satisfaction refers to the attraction, pride, or positive feeling that the students develop toward the program or institution (Danielson, 1998; Hatcher et al, 1992). (Strike, 1984) indicated that the level of students' positive feeling or satisfaction is associated with students' being able to find adequate resources to meet their academic and social interests. The students' ability to project and implement their self concepts as a students or viewing themselves as part of the institution is also related to their positive feeling of satisfaction (Sedlacek, 1987; Stikes, 1984). The students' positive feeling and satisfaction is also contingent to the students' academic and social experiences obtained at the particular institution (Aitken, 1982; Betz, Menne, Starr, and Klingensmith, 1971; Danielson, 1998; Hatcher, et al., 1992; Stikes 1984; Tinto, 1993). The academic and social experiences of students are the vehicles that drive students into the life of the institution (Tinto, 1993). In his Interaction theory into student satisfaction, he argues that student persistence can be predicted by their degree of integration. He refers to two kinds of integration; academic and social integration. Academic integration refers to how students perform academically (grades) and social integration is how the students interact with faculty (Suhre et al., 2006).

Previous studies have shown that students who report positive academic and social experiences expressed greater satisfaction with their overall college experience (Bailey, et al., 1998; Danielson, 1998; Tinto, 1993). Other key determinants of student satisfaction include academic performance, quality of curriculum, quality of instruction, and quality of academic advising. Likewise, students with major dissatisfaction concerns ~~show~~ an unhealthy level of isolation (Aitken, 1982). Interaction between faculty members and students is also a factor affecting student satisfaction in their academic experiences (Betz, et al., 1971; Love, 1993; Tinto, 1993). This implies that sufficient and positive faculty-student interaction will contribute to overall student satisfaction (Danielson, 1998; Tinto, 1993). Interaction with fellow students is also associated with student satisfaction (Aitken, 1982).

An analysis of the determinants of overall student satisfaction of 1,212 business seniors was conducted using the Undergraduate Business Exit Assessment. A factor analysis of the student's responses resulted in the determination of eight factors which are distinct from those proposed by the providers of this standardized instrument: self-confidence, satisfaction with the curriculum, instruction, and classes, satisfaction with quality of teaching of subject matter, satisfaction with extra-curricular activities and career opportunities, satisfaction with student advising, quality of teaching and instructor feedback, satisfaction with computing facilities, and satisfaction with student quality and interaction. Stepwise regression analysis was used to determine the strength of the relationship between those factors and three alternative measures of overall satisfaction: were expectations met? What is the value of the educational investment made? And would you recommend the program to a friend? Regression results showed that advising and quality of teaching in the subject matter had little or no effect on overall student satisfaction.

Self-confidence, extra-curricular activities and career opportunities, and quality of teaching in general are the factors with greater impact on satisfaction. (Letcher and Neves, 2009) concluded that all the regression coefficients were positive, self confidence has the greatest impact on student satisfaction and also satisfaction with advising services does not contribute to overall student satisfaction.

Several studies into student satisfaction and priorities have focused on different aspects of the educational experience. This is usually based on the definition of student satisfaction given by the research team or due to a dearth of resources to carry out an extensive enquiry into the subject. Several hypotheses have been tested and pools of conclusions have been reached. The reasons for embarking on this research into students' satisfaction spawn from a desire to make recommendations to policy makers to make necessary adjustments and introductions into the college of science, KNUST, to improve student services and opportunities.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

In this section, we discuss the statistical methodologies that will be used in analyzing the "student satisfaction dataset.

3.2 The ordinal regression model

The ordinal regression procedure allows one to build models, generate predictions, and evaluate the importance of various parameters in cases where the response variable is of the ordinal nature. Several texts that discuss logistic regression are (Cox and Snell, 1989), (Collett, 1991), (Agresti, 1990), and (Hosmer and Lemeshow, 1989).

Ordinal regression model belongs to a powerful class of models called the generalized linear models (GLM) which are able to solve a lot of statistical problems. The basic form of the ordinal regression model looks like

$$link\left[\theta_k(x_i)\right] = \theta_k + \left[\beta_1 x_1 + \beta_2 x_2 + \dots + \beta_q x_q\right] \quad (1)$$

Where

$link$	is the link function
k	is the number of cut points
$\theta_k(x_i)$	~~is the~~ cumulative logit up to and including category k.
α_k	is the threshold up to and including category
t	is the number of regression parameters
$x_1, x_2, \dots, x_q$	are the predictor variables.

The model is based on the assumption that there is an underlying continuous variable and that the ordinality of the responses arise from the discretization of the underlying continuum into ordered groups called categories. The cut points or kinks that define the categories are defined by the threshold. In some cases there is theoretical justification for assuming such an underlying distribution. However, even in cases where there is no theoretical justification for assuming such an underlying continuous variable, the model can perform quite well and give valid results, other things being equal. The threshold in the model depends only on the category whose probability is being predicted. Values of the predictor variable do not affect this part of the model (SPSS, 1998). The prediction part of the model depends only on the predictors and is independent of the outcome category. These properties surmise that the results will be a set of parallel lines or planes (one for each category or cut point of the response variable); student satisfaction: very dissatisfied, dissatisfied, don't know, satisfied, very satisfied.

Rather than interpreting the actual cumulative probabilities, the model predicts a function of cumulative probabilities. This function is called a link function and the researcher gets to choose the form of the link function when building a model. The procedure for choosing a link function is not set in stone. However, many researchers follow these conventions;

Generally, the logit link is considered suitable for analyzing ordered categorical data evenly distributed among all categories; the clog log link is often used to analyze ordered categorical data when higher categories are more probable. In a negative log-log link function, lower categories are more probable and our data set is appropriate for this function.

The location component of an ordinal regression model is the meat of the model. It uses the predictor variables to calculate the predicted probabilities of membership in the categories for each case.

The scale component is an optional modification to the basic model that corrects the differences in variability for different values of the predictor variable. For example, if the variability in the account holdings of men is different from the variability in the account holding of women, then the scale component will make up for the difference in variability between the two sets of account holdings.

$$link\left[\theta_k(X_i)\right] = \frac{\alpha_k + \left[\beta_1 X_1 + \beta_2 X_2 + \dots + \beta_i X_i\right]}{\left[\exp(\tau_1 Z_1 + \dots + \tau_m Z_m)\right]} \tag{2}$$

where $\tau_1, \tau_2, \dots, \tau_m$ are the scale component coefficients and $Z_1, Z_2, \dots, Z_m$ are the scale component predictors.

3.3 Sampling Method

The data arose from a stratified simple random sample or was at least conceptually representative of a stratified population, so they have the following likelihood function:

$$P\{n_{hijk}\} = \prod_1^2 \prod_1^4 \prod_1^9 n_{hij+}! \prod_1^5 \frac{\prod hijk^{n_{hijk}}}{n_{hijk}!} \tag{3}$$

Where $\sum_1^5 \pi_{hijk} = 1$

One could write a model that applied to all logits simultaneously for each combination of the explanatory variables as:

$$\operatorname{logit}\left[\theta_k(x_i)\right] = \alpha_k + x_i'\beta_k \tag{4}$$

where k indexes the $(k-1)$(4 logits). This says that there are separate intercept parameters $\{\alpha_k\}$ and different sets of regression parameters $\{\beta_k\}$ for each logit. Taking the difference in logits between two subpopulations for this model, gives

$$\log it\left(\theta_{hijk}\right) - \log it\left(\theta_{hij'k}\right) = \left(x_{hij} - x_{hij'}\right)\beta_k \quad \text{for k=1,2,3,4} \tag{5}$$

3.4 Preliminary Analysis

In statistics, the Cochran–Mantel–Haenszel statistics are a collection of test statistics used in the analysis of stratified categorical data. One of these test statistics is the Mantel–Haenszel (CMH) test, which allows the comparison of two groups on a dichotomous/categorical response. It is used when the effect of the explanatory variable on the response variable is influenced by covariates that can be controlled

In the CMH test, the data are arranged in a series of associated 2 × 2 contingency tables, the null hypothesis is that the observed response is independent of the treatment used in any 2 × 2 contingency table. The CMH test's use of associated 2 × 2 contingency tables increases the ability of the test to detect associations (the power of the test is increased).

3.5 Fitting the Model

We utilize the method of maximum likelihood to estimate the parameters of the ordinal logistic function (4). Appropriate cumulative logits were formed using the cell probabilities. Let $\pi_1(x_i), \pi_2(x_i), \ldots, \pi_k(x_i)$ denote the response probabilities (the probability of being "very dissatisfied, dissatisfied, don't know, satisfied or very satisfied") with the overall college experience at a value for a set of explanatory variables (x_i) being gender of the student, level of the student and the department of the student. First form cumulative probabilities as follows;

$$\theta_k(x_i) = P(Y \le k | x_i) = \pi_1(x_i) + \pi_2(x_i) + \dots + \pi_k(x_i) \tag{6}$$

Cumulative logits are then formed as follows:

$$L_k = \log it\left[\theta_k(x_i)\right] = \log\left(\frac{\theta_k(x_i)}{1-\theta_k(x_i)}\right), \text{ for k=1,2,3,4} \tag{7}$$

These cumulative logits $\{O_k\}$ where $k = 1,2,3,4$ are the log odds of the kth cumulative probability relative to its complement. Log odds may focus on more favorable to less favorable response or vice versa. The proportional odds model takes both of these odds into account (Stoke et al., 2000).

3.6 Proportional odds model assumption

The proportional odds assumption states that $\beta_k = \beta$ for all values of k which translates

$$\log it\left[\theta_k(x_i)\right] = \alpha_k + x_i'\beta_k$$

to

$$\log it\left[\theta_k(x_i)\right] = \alpha_k + x_i'\beta$$

(8)

One of the assumptions underlying ordinal logistic (and ordinal probit) regression is that the relationship between each pair of outcome groups is the same. In other words, ordinal logistic regression assumes that the coefficients that describe the relationship between, say, "very dissatisfied" versus all higher categories ("dissatisfied through very satisfied") of the response variable are the same as those that describe the relationship between the next lower category ("dissatisfied") and all higher categories ("don't know through very satisfied"), etc. This is called the proportional odds assumption or the parallel regression assumption. Because the relationship between all pairs of groups is the same, there is only one set of coefficients. If this was not the case, we would need different sets of coefficients in the model to describe the relationship between each pair of outcome groups. For a single continuous explanatory variable, the regression lines would be parallel to each other, and their relative positions determined by the values of the intercept parameter. However, these tests have been criticized for having a tendency to reject the null hypothesis (that the sets of coefficients are the same), and hence, indicate that the parallel slopes assumption does not hold, in cases where the assumption does hold.

3.7 Inferences about Regression Parameters

The inferences about the regression parameter estimates, estimation of means, and predictors of new observation are considered under this section. In this study, tests concerning single parameters were done using the Wald test. Goodness of fit, score test, likelihood ratio test, AIC, SC, etc are used to test for suitability of models.

3.7.1 Proportional odds test

This is a test for the appropriateness or suitability of the proportional odds assumption. Though a complete model could be fitted such that all explanatory variables would carry an attendant unique parameter estimate ("$\{\beta_k\}$"), the proportional odds test sets up a model where all the parameter estimates for the explanatory variables are equal "β". The parameter estimates are constrained to be equal across all of the logits. Thus the model considered is

$$\text{logit}\left[\theta_k(X_i)\right] = \alpha_k + X_i'\beta$$

The hypothesis tested is that: there is a common parameter vector β instead of distinct β_k. The hypothesis can be stated as $H_0: \beta_k = \beta$ for all k. Thus, if the researcher rejects the null hypothesis, he or she has rejected the assumption of proportional odds and needs to consider a different approach, such as modeling generalized logits. If the null hypothesis is not rejected, then the test supports the assumption of proportional odds. Since the test is comparing t parameters for the t explanatory variables across $(k-1)$ which is 4 logits, where k is the number of response levels, it has $q*(k-2)$ degrees of freedom.

The partial proportional odds model is an alternative model that can be fit when the proportionality assumption does not hold for all explanatory variables, but there is proportionality for some. When there appears to be no proportionality, the best approach may be to treat the data as nominal and fit a model to the generalized logits.

Analytically, the proportional odds test is a chi square procedure that examines the assumption; $\beta_k = \beta$ for all k to be tested for its veracity. GEE (Generalised Estimating Equations) methods are used to fit models that show partial proportionality (Peterson and Harrel, 1990).

3.7.2 Goodness of fit test

The evaluation of goodness of fit for the proportional odds model is similar to the evaluation of goodness of fit for the dichotomous response logistic regression model. Given a sufficient sample size, with about 80% of the observed cell counts at least 5, then one can use counterparts of Q_p and Q_L is distributed as chi-square with $\{(k-1)(s-1)-q\}$ where q is the number of explanatory variables, k is the number of response levels, and s is the number of subpopulations.

$$Q_p = \frac{\left(n_{ij} - n_{i+}\hat{\theta}_i\right)^2}{n_{i+}\hat{\theta}_i\left(1-\hat{\theta}_i\right)} \tag{9}$$

with $(s-q-1)$ degrees of freedom.

$$Q_L = \sum\sum 2n_{ij}\log\left(\frac{n_{ij}}{n_{i+}\hat{\theta}}\right)$$

(10)

Where j=1,2 for the categories of the response variables.

3.7.3 Global tests

These are tests for assessing model fit through the explanatory capability of the model. Namely; the likelihood ratio test, the score test and the Wald test.

3.7.3.1 Score or Lagrange test

To perform the score test, one starts with a very parsimonious or rather thrifty model with few terms. The score test process measures how much it hurts the fit of the model to the observed data by omitting the remaining parameters or some particular parameters (the score test uses a model with fewer variables and tests for omitted variables). This test checks whether the missing variables were incorrectly omitted. The results of the score test are chi-squared distributed with degrees of freedom equal to the number of variables added to the model. The outputs are; test statistic, the number of degrees of freedom for the test, and the p-value associated with a chi-squared of a given value with a given number of degrees of freedom. The score test adds variables to the initial model one at a time and without keeping the latest term adds another variable and then finally adds the interaction terms (simultaneous test) of the omitted variables.

3.7.3.2 Wald test

The Wald test approximates the likelihood ratio test, but with the advantage that it only requires estimating one model. The Wald tests whether the parameters of interest are simultaneously equal to zero. If they are, this strongly suggests that removing them from the model will not substantially reduce the fit of the current model under consideration, since a predictor whose coefficient is very small relative to its standard error is generally not doing much to help predict the dependent variable. The first step in performing a Wald test is to run the saturated model (i.e., the model containing all predictor variables and possibly (interaction terms). The Wald test investigates whether the coefficients for these variables are simultaneously equal to zero. The hypothesis to be tested is $H_0 : \beta_k = 0$ for $k = 1,2,3,4$.

An observed chi-squared value generated by the Wald test, as well as an attendant p-value associated with the chi-squared degrees of freedom give the premise to reject or accept the null hypothesis. An appropriate test statistic and decision rule is given below:

The test statistic is : $Z^{*} = \dfrac{\beta_k}{se\{\beta_k\}} \sim N(0,1)$

(11)

And the decision rule is:

If $\left|Z^{*}\right| \leq Z_{1-\frac{\alpha}{2}}$, conclude that $\beta_k = 0$ and

If $\left|Z^{*}\right| \geq Z_{1-\frac{\alpha}{2}}$, conclude that $\beta_k \neq 0$.

3.7.3.3 The likelihood ratio test

Let L_1 be the maximum value of the likelihood of the data without the additional assumption. In other words, L_1 is the likelihood of the data with all the parameters unrestricted and maximum likelihood estimates substituted for these parameters. Let L_0 be the maximum value of the likelihood when the parameters are restricted (and reduced in number) based on the assumption. Assume k parameters were lost (i.e., L_0 has k less parameters than L_1). Form the ratio $\lambda = L_0/L_1$. This ratio is always between 0 and 1 and λ varies directly with the likelihood of the assumption. The likelihood ratio test tests the hypothesis that: there is no significant difference between the enervated model and the saturated model. This can be quantified at a given confidence level as follows;

1. Calculate $\chi^2 = -2\ln(\lambda)$. The smaller is the larger χ^2 will be.
2. We can tell when χ^2 is significantly large by comparing it to the upper $100(1-\alpha)$ percentile point of a Chi Square distribution with k degrees of freedom. $\cancel{\chi^2}$ ~~has an~~ approximate Chi-Square distribution with k degrees of freedom and the approximation is usually good, even for small sample sizes.
3. The likelihood ratio test computes χ^2 and rejects the assumption if χ^2 is larger than a Chi-Square percentile with k degrees of freedom, where the percentile corresponds to the confidence level chosen by the analyst.

3.8 Model Selection Methods

Several automated model selection methods are available for choosing the best ordinal regression model. The various contestant models arise from using forward selection, backward selection and varying the link function. In this study we use the AIC and SC. θ_k is the estimated probability of the observed response. $\boldsymbol{L}$ is the likelihood function and

f_k is the frequency value for the kth observation.

Akaike Information Criterion (AIC)

$$AIC = -2\log(L) + 2(k+t) \tag{13}$$

Schwarz Criterion (SC)

$$SC = -2\log(L) + 2(k+t)\log\left(\sum_k f_k\right) \tag{14}$$

Where k is the number of logits and q is the number of explanatory variables. The AIC and SC statistics give two different ways of adjusting the -2 Log Likelihood statistic for the number of terms in the model and the number of observations used. Lower values of the statistic relative to that of the competing model(s) indicate a more desirable model.

3.9 Parameter estimates

The main effects ~~model is~~ usually a good starting point for data analysis. It may be quite unwieldy for large matrices though. This is very similar to the models used to describe dichotomous responses but in this case there are four intercept parameters corresponding to the four cumulative logit functions being modeled for each group (Stokes et al., 2000). This model can also be stated as

$$\theta_k(x_i) = \frac{\exp\left(\alpha_k + x_i'\beta\right)}{1 + \exp\left(\alpha_k + x_i'\beta\right)} \quad (15)$$

and written in summation notation as;

$$\theta_k(x_i) = \frac{\left\{\alpha_k + \sum_g^q \beta_g x_{ig}\right\}}{1 + \left\{\alpha_k + \sum_g^q \beta_g x_{ig}\right\}} \quad (16)$$

Where $g = (1,2,\ldots,q)$ refers to the explanatory variables. This model is fit with maximum likelihood methods. The values of (the cell probabilities) π_i can be determined by performing the appropriate subtractions on the appropriate $\theta_k(x_i)$.

The parameter estimates can be obtained from the equation

$$\frac{\theta_k(x_i)}{1 - \theta_k(x_i)} = \alpha_k + \sum_{k=1}^{q} \beta_k x_k \quad (17)$$

The $\{\theta_k(x_i)\}$ represent cumulative probabilities up to the desired cut point. $\{\theta_k(x_i)\}$ is the probability of being satisfied up to the *kth* level of satisfaction, and $\{\theta_1(x_i)\}$ is the probability of being "very dissatisfied" expressed as a function of x_i (where $x_1 = gender$, $x_2 = year$, $x_3 = department$).

3.10 Interpretation of Parameter Estimates

The parameter estimates table summarizes the effect of each predictor. While interpretation of coefficients in this model is difficult due to the nature of the link function, the signs of the coefficients for factor levels can give important insights into the effects of the predictors in the model. For covariates, positive (negative) coefficients indicate positive (inverse) relationships between predictors and outcome.

An increasing value of a covariate with a positive coefficient corresponds to an increasing probability of being in one of the "higher" cumulative outcome categories. For factors, a factor level with a greater coefficient indicates a greater probability of being in one of the "higher" cumulative outcome categories. The sign of a coefficient for a factor level is dependent upon that factor level's effect relative to the reference category. Having chosen the model with the logit link, we can make some interpretations based on the parameter estimates.

β_1 posits an incremental effects for gender, which actually means a step shift in gender (i.e. a movement from male to female) results in an expected "β_1" change in "the level of satisfaction of a student chosen at random" on the log odds scale while holding all other variables (the level of the student in question and the department where student belongs) constant.

β_2 suggests an incremental effects for level, which actually means a unit change in " year of study" (year one through four) results in an expected "β_2" change in "the level of satisfaction of a student chosen at random" on the log odds scale while holding all other variables (the gender of the student in question and the department where student belongs) constant.

β_3 smacks of an incremental effects for department, which actually means a unit change department (any one step movement from actuarial science through physics) results in an expected "β_3" change in "the level of satisfaction of a student chosen at random" on the log odds scale while holding all other variables (the level of the student in question and the gender of the said student) constant.

$\{\alpha_k\}$ is the log odds based on the predefined cut point for the reference cell; which makes

α_1 the log odds of being "very dissatisfied" and α_2 the log odds of being "dissatisfied". The $\{\alpha_k\}$ get their definition based on the cut point and the reference cell only.

3.11 Odds Ratio Estimates

Odds ratios give a relatively simple meaning to the parameter estimates; the chances of being a higher category (the collapsing of the adjacent categories "satisfied" and "very satisfied" into one category) versus the chances of being in a lower category (the collapsing of the adjacent categories; "very dissatisfied", "dissatisfied" and "don't know" into one category). The odds ratio for female versus male is given by $\exp(\beta_1)$. The odds ratios are computed from the ratio of appropriate cell probabilities.

Exp(Parameter estimate) gives the odds ratio of the parameter estimate. The odds ratio estimates are formed for pair wise comparisons of the various levels of an explanatory variable. The odds ratio expresses the propensity of falling into one category instead of the other (Stokes, Davis, and Koch, 2000). The cumulative probabilities turn the response categories from each subpopulation into a dichotomous response and hence allow for the calculation of odds ratios using;

$$\theta_k(x_i) = \frac{\left(\sum b \le k \pi_{i,b}\right)\left(\sum b > k \pi_{i+1,b}\right)}{\left(\sum b > k \pi_{i,b}\right)\left(\sum b \le k \pi_{i+1,b}\right)} \tag{18}$$

3.12 Justification of Variables

The variables "gender", "level" and "department" were chosen for this research because they are the pervasive ones in all researches into student satisfaction. These criteria about a student are readily available and verifiable and are the best way to describe a student picked at random. There are hidden variables like; expectations of the student, tastes and preferences of the student, among others but the subjectivity of these variables and the difficulty associated with measuring these variables makes them omitted in this research.

The questionnaires touched on all relevant topics to the academic experience. Faculty, curriculum content, financial aid services, library services, personal counseling, classroom facilities, laboratory facilities, housing facilities, student recreation, cultural events, and social events were expressed as determinants of student satisfaction. Student politics and health services on the college of science, KNUST, campus were also considered. The gender of a respondent, length of stay on KNUST campus and department of the respondent coupled with the respondents' appraisal of the above mentioned topics were expressed as a function of "the overall college experience". The response level "don't know" carried a lot of ambiguity though. In essence it captured all the sentiments that could be expressed between being "satisfied" and "dissatisfied" including its literal meaning. It is easily interpreted to mean "being indifferent" in the context of this research. This interpretation is justified because of the fuzzy nature of the response levels.

CHAPTER FOUR

DATA ANALYSIS AND DISCUSSION OF RESULTS

4.1 Introduction

Chapter four covers the outputs as they are presented by SAS (version 8). The outputs here follow from the methodology described in chapter 3 of this research. Results from backward selection are displayed in this chapter.

4.2 Data Description

The population for this study is all students from year one through four of the college of science, KNUST. Stratified sampling and its processes determined the sample size and data collection method. Of the 750 questionnaires that were administered, 734 were returned. The returned questionnaires were checked for item non response and inconsistency in the responses. Some of the questionnaires suggested cynicism on the part of the respondents so they were eliminated from the pool of viable questionnaires to be analysed. Questionnaires with item non response were equally considered invalid for this analysis. After the data cleaning 662 questionnaires were left to be analysed. The questionnaire asked respondents to rank the questionnaire items on a five point Likert scale. The ranks considered were; "very dissatisfied=1, dissatisfied=2, don't know=3, satisfied=4 and very satisfied=5", with "very dissatisfied" being the least ranked and "very satisfied" being the highest in the rankings. 20 questions were asked to put the overall college experience into perspective. The 21st question then asked the respondents to rank the overall college experience on a five point Likert scale. There was representation from all departments and levels.

4.3 Assumptions

A student picked at random was assumed to be fully aware or informed of all facilities and events occurring in the university community. No knowledge or an unclear understanding of a facility or event in the university is not attributed to the student in any way; information dissemination in the university is perfect. This means every student is equally exposed to opportunities and facilities. Also, a student picked at random was deemed to find more of a desirable facility or event preferable to less of the desirable facility or event. A student picked at random was assumed to be rational in the choices he/she made; showing consistency in the ordering of the level of satisfaction of student facilities and events.

4.4 Results of preliminary analysis

The outputs are briefly described in this section. The distribution of responses show that; 1% of the respondents reported being "very dissatisfied", 23% reported being "dissatisfied", 29% reported "don't know", 21% and 26% reported being "satisfied" and "very satisfied" respectively. Two hundred and nine (209) of the respondents were from year one, 180 from year two, 128 from year three and 145 from year four.

Table 1: Gender by response

Gender	**Level of response**					**Total**
	1	**2**	**3**	**4**	**5**	
Female (f)	44	73	71	65	27	280
Male (m)	65	100	71	91	36	363
Total	109	173	142	156	63	643

Table 1 above describes the 2x5 contingency table of gender by response level. The cell counts describe the frequency distribution in the sample. It was observed that category 5 being "very satisfied" recorded the least being 63 and category 2 (dissatisfied) recorded the highest frequency of 173.

The Cochran-Mantel-Haenszel test statistic value of 0.1215 (p-value =0.7274) showed that at the 10% level of significance gender and increase in level of satisfaction with the college experience are independent.

Table 2: Crosstab of department by response

Table of department by response						
Department	**Response**					**Total**
	1	**2**	**3**	**4**	**5**	
Actuarial	8	16	12	16	7	59
Biochemistry	12	19	20	26	9	86
Biology	8	22	16	17	6	69
Chemistry	12	19	18	18	6	73
Computer	11	18	13	20	9	71
Food	19	21	18	15	5	78
Mathematics	11	21	20	16	5	73
Optometry	12	22	16	14	9	73
Physics	16	15	10	14	7	62
Total	109	173	143	156	63	644

Table 2 describes the frequency distribution of response levels with respect to departments. This distribution allows for a test of conditional independence to test for the viability of department as a determinant of student satisfaction. All cell frequencies are greater or equal to 5. The largest of them all is 26 from biochemistry responding as being "satisfied".

The Cochran-Mantel-Haenszel test statistic value of 03.6591 (p-value =0.0558) showed that at the 10% level of significance that department is associated with the response level of students in terms of their college experience.

Table 3: Crosstab of response by Year of study

Level	Response					Total
	1	2	3	4	5	
Year one	26	53	46	54	21	200
Year two	28	44	35	46	18	171
Year three	26	37	34	24	7	128
Year four	29	39	28	32	17	145
Total	109	173	143	156	63	644

Table 3 describes the frequency distribution of response levels with respect to level of student (length of exposure to the college experience). This crosstab gives the basis for a sequential 2x2 analysis of the relationship between year of study and the response level.

The level of a student has a significant effect on the response level of a student with respect to matters concerning student satisfaction. At 10% level of significance, from the Cochran-Mantel-Haenszel test it shows that "year of study" and "level of satisfaction" of students are not independent.

Analysis of data for model 1:-(2x4x9x5 contingency table)

The "Response Profile in appendix B shows that the response variable values are ordered in terms of decreasing levels of satisfaction (very satisfied through very dissatisfied). Thus, the cumulative logits modeled are based on more to less levels of student satisfaction. For this data, zero cell frequencies is not a problem since the total row counts are acceptably large. Computationally, zero counts are discarded. The model still produces predicted values for the cells that corresponded to the zero cells.

4.5 proportional odds assumption

Table 4: Score test for proportional odds assumption

Chi-Square	DF	Pr > Chi Sq
50.2601	36	0.0576

This output in Table 4 is a test for the appropriateness of the proportional odds assumption. Thus, the model considered is

$$\log it\left[\theta_k(x_i)\right] = \alpha_k + x_i'\beta_k$$

The ~~hypothesis~~ tested ~~here~~ is that there is a common parameter vector "β" instead of distinct "β_k". The hypothesis can be stated as $H_0 : \beta_k = \beta$ for all *k*. Thus, if one rejects the null hypothesis, it translates into rejecting the assumption of proportional odds. If the null hypothesis is not rejected, then the test supports the assumption of proportional odds. The chi square statistic takes the value 50.2601 with 36 degrees of freedom. This is nonsignificant and so we can conclude the assumption of proportional odds is a reasonable one for this data.

Table 5: Test for the global null hypothesis

Test	Chi-Square	DF	Pr > ChiSq
Likelihood Ratio	20.8107	12	0.0532
Score	20.3718	12	0.0604
Wald	20.6456	12	0.0558

From Table 5, the tests for assessing model fit through explanatory capability are also supportive of the model; the likelihood ratio test has a value of 20.8107 with 12 degrees of freedom and the Wald test has a value of 20.6456 with 12 degrees of freedom, as displayed in the output above. Both tests suggest that the explanatory capacity of the model are marginally significant, which means give or take , the models are able to describe the patterns in the distribution of the data on student satisfaction.

Table 6: Type III analysis

Effect	DF	Wald Chi-Square	Pr > Chi Sq
Gender	1	0.0054	0.9412
Year of study	3	9.7975	0.0204
Department	8	12.0347	0.1497

The type three analyses of effects suggest that gender and department are not so influential in determining student satisfaction in KNUST. However, the year of study of a student is very influential in determining student satisfaction as shown in Table 6.

Table 7: Odds ratio estimates

EFFECT	POINT ESTIMATE	95% WALD CONFIDENCE LIMIT
gender M vs. F	1.011	(0.762; 1.340)
Year one vs. year four	0.945	(0.654; 1.365)
Year two vs. year four	0.609	(0.413; 0.899)
Year three vs. year four	1.094	(0.728; 1.645)
ACTURIAL vs. PHYSICS	2.281	(1.204; 4.324)
BIOCHEM vs. PHYSICS	2.102	(1.149; 3.845)
BIOLOGY vs. PHYSICS	2.167	(1.187; 3.955)
CHEMISTRY vs. PHYSICS	1.490	(0.818; 2.712)
COMPUTER vs. PHYSICS	1.856	(1.001; 3.439)
FOOD vs. PHYSICS	1.901	(1.051; 3.437)
MATHS vs. PHYSICS	1.787	(0.962; 3.322)
OPTOMETR vs. PHYSICS	1.287	(0.699; 2.369)

From Table 7 females had 1.011 greater odds of recording higher levels of satisfaction than males, for all four logits. Year one students had 0.945 higher odds of reporting higher levels of satisfaction than year four students. Year two students had 0.945 higher odds of reporting higher levels of satisfaction than year four students. Year three students had 1.094 greater odds of reporting higher levels of satisfaction than year four students. Actuarial science students had 2.281 higher odds of reporting higher levels of satisfaction physics students. Biochemistry students had 2.102 higher odds of reporting higher levels of satisfaction than physics students. Biology students have 2.167 higher odds of reporting higher levels of satisfaction physics students. Chemistry students had 1.49 higher odds of reporting higher levels of satisfaction than physics students. Computer science students had 1.856 higher odds of reporting higher levels of satisfaction than physics students. Food science students had 1.901 higher odds of reporting higher levels of satisfaction than physics students. Mathematics students had 2.281 higher odds of reporting higher levels of satisfaction than physics students. Optometry students had 1.287 odds of reporting higher levels of satisfaction than physics students.

Table 8: Goodness of fit

Criterion	Value	DF	Value/DF	Pr > Chi Sq.
Deviance	275.2164	268	1.0269	0.3678
Pearson	233.4912	268	0.8712	0.9371

The goodness of fit test from Table 8 supports or debunks the adequacy of the model. With values of 275.2164 and 322.4912 and their respective degrees of freedom being 268 and 268 respectively, the Pearson chi square statistic supports the adequacy of the model but the log-likelihood ratio statistic does not support the adequacy of the model. Nonsignificant results are equally informative, however.

Analysis of data for model 2:-(2x2x2x5 contingency table)

After redefining the criteria for categorizing the variables used in determining student satisfaction, a new contingency table (2x2x2x5) is formed and the results of analyzing this new contingency table. The new categories were formed from collapsing adjacent categories to form homogeneous categories with large cell frequencies. The length of exposure to the college experience was categorized into juniors (levels 100 and 200) and seniors (levels 300 and 400). The nine departments were also categorized into old (mathematics and actuarial, physics, chemistry, biology and computer) and new (optometry, food, biochemistry). The reason for recatagorization was to give the test of association some more power compared to the previous categorization.

Table 9: Score test for POA

Score Test for the Proportional Odds Assumption		
Chi-Square	DF	Pr > Chi Sq
3.3058	3	0.3468

The Table 9 above shows the test that assesses the validity of the proportional odds assumption for the variable "gender" (the assumption of common slopes for all of the cumulative logits). The observed p-value from Table 9 does not lead to rejection of the proportional odds assumption.

Table 10: Analysis of ML estimates

Analysis of Maximum Likelihood Estimates						
Parameter		**DF**	**Estimate**	**Standard Error**	**Wald Chi-Square**	**Pr > Chi Sq**
Intercept	**1**	1	-1.5943	0.1055	228.1954	<.0001
Intercept	**2**	1	-0.2525	0.0800	9.9730	0.0016
Intercept	**3**	1	0.6604	0.0836	62.3403	<.0001
Intercept	**4**	1	2.2186	0.1329	278.7188	<.0001
gender	**f**	1	-0.0269	0.0706	0.1447	0.7036

The "Analysis of Maximum Likelihood Estimates" in Table 10 includes an intercept for each logit. The intercept parameters quantify the "shift" in location between the four cumulative logits being modeled. The intercept parameters, however, are seldom of practical importance.

The odds ratio for gender (female vs. male) from Table 10 is exp(-0.0269) = 0.9735 and is statistically not significant (p-value=0.7036). The 95% confidence interval for the odds ratio is [0.719; 1.25]

Because the proportional odds assumption was not rejected, the conclusion is that in this sample, "gender" (being male or female), has no effect on the choice of response level a student selects in terms of their satisfaction with the "college experience". Importantly, this interpretation holds across the entire range of satisfaction, from "very dissatisfied" through "very satisfied".

Table 1: Score test for POA

Score Test for the Proportional Odds Assumption		
Chi-Square	**DF**	**Pr > Chi Sq**
4.5693	9	0.8701

The Table 11 below shows the test that assesses the validity of the proportional odds assumption for the variables "gender, level and department" under their new definitions for recatagorization (the assumption of common slopes for all of the cumulative logits). The score test for the proportional odds assumption is not statistically significant p=.0.8701), so we do not reject the assumption of parallel slopes. The observed p-value does not lead to rejection of the proportional odds assumption.

Table 12: Analysis of ML estimates

Parameter		DF	Estimate	Standard Error	Wald Chi-Square	Pr > Chi Sq	Exp(Est)
Intercept	**5**	1	-2.4430	0.1871	170.4314	<.0001	0.087
Intercept	**4**	1	-0.8775	0.1537	32.5945	<.0001	0.416
Intercept	**3**	1	0.0363	0.1496	0.0588	0.8084	1.037
Intercept	**2**	1	1.3861	0.1623	72.9026	<.0001	3.999
gender	**f**	1	0.0720	0.1420	0.2574	0.6119	1.075
year	**1**	1	0.3394	0.1473	5.3072	0.0212	1.404
department	**1**	1	-0.0251	0.1504	0.0278	0.8677	0.975

The "Analysis of Maximum Likelihood Estimates" in Table 12 includes an intercept for each logit. The intercept parameters quantify the "shift" in location between the four cumulative logits being modeled. The intercept parameters, however, are seldom of practical importance.

Table 13: Odds ratio for gender, year of study and department

Odds Ratio Estimates			
Effect	**Point Estimate**	**95% Wald Confidence Limits**	
gender f vs. m	1.075	0.814	1.419
year 1 vs. 0	1.404	1.052	1.874
d 1 vs. 0	0.975	0.726	1.310

The odds ratio for gender (female vs. male) is exp(0.0720) = 1.07466, level (juniors vs. seniors) is exp(0.3394) = 1.40415 and department (old vs. new) is exp(-0.0251) = 0.9752 are given as displayed in Table 13. The parameter estimates for gender and department are not significant while that of level (juniors vs. seniors) is statistically significant.

Because the proportional odds assumption was not rejected, the conclusion is that in this sample, "gender and department" (being male or female and being in an old or new department) has no effect on the choice of response level a student selects in terms of their satisfaction with the "college experience". Clearly, the length of exposure to the college experience is significant in the students 'decision to choose a response level to describe the college experience. Importantly, this interpretation holds across the entire range of response levels being "very dissatisfied" through "very satisfied".

The year of study was associated with a 1.404 fold (95% CI, 1.052-1.874) increased odds of expressing a satisfactory response with the college experience.

CHAPTER FIVE

FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

Chapter four gave us statistical measures. Measures of strength of associations, measures that could help make valid statistical conclusions and hence generalizations. In line with the methodology in chapter three and marrying it with the content from the literature review in chapter two, we make generalizations about the subject of "analyzing student satisfaction in College of Science, KNUST". The objectives of this research are reached in this chapter.

The findings, discussions and recommendations are addressed in this chapter. All the results of chapter four are thoroughly elaborated upon with respect to other research into the subject of students' satisfaction.

5.2 Findings

The preliminary tests (CMH) showed that gender was not a significant variable for determining students' satisfaction in the College of Science. Department was loosely associated with student satisfaction. On the other hand, the year of study was a significant variable for determining students' satisfaction.

The type three analysis of this data also suggested that student satisfaction was influenced greatly ~~by the length~~ of stay on KNUST campus (length of exposure to the college experience). An ordering of the variables used in this research on the basis of their ability to influence student satisfaction has "level" of the student being the most influential, followed by the "department" of the student and then "gender" of the student.

Department was loosely associated with student satisfaction. Chen and Hughes (2004) also concluded that gender and department were not significant in determining student satisfaction when they used ordinal regression to analyze student satisfaction data. Year two students however, responded as being "dissatisfied.

It was found that, the response of students from the senior classes (year three and four) was with greater probability (sensitivity or specificity) of being valid than that of the junior classes (year one and two). In other words, their opinions had more weight than the juniors. The length of exposure was greater for seniors and they had a better understanding of the college experience.

5.3 Conclusion

The conclusion of this research is that, to collect students opinions concerning satisfaction on any issue in the college of Science, the opinions of the seniors should necessarily be sought and given more weight. Gender and Department should not necessarily form part of the criteria for selecting respondents for future inquiries into students' satisfaction concerns with the college experience.

5.4 Recommendation

I recommend that, future research should focus on one major factor that affects students satisfaction ~~at a time~~ (e.g. academic performance, quality of curriculum, quality of instruction, quality of academic advising and accommodation) because the academic and social experiences of students are the vehicles that drive students into the life of the institution (Tinto, 1993).

Kotler et al. (2009) defined satisfaction as 'a person's feeling of pleasure that resulted from comparing a product's perceived performance (or outcome) to their expectation. The product here is any of the listed indicators of student satisfaction, so further research should focus on specific determinants of satisfaction.

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APPENDICES

APPENDIX A

QUESTIONNAIRE

Questionnaire Items	1	2	3	4	5
1- My department met my expectations.					
2- The number of elective courses is adequate.					
3- Classroom, workplace, equipment and technical facilities are adequate.					
4- There are enough scientific, social and cultural activities at the university.					
5- The student union works effectively.					
6- The scholarship opportunities are adequate.					
7- It is easy to benefit from student exchange programs.					
8- The university administration believes that it is important to delegate some decision making to the students.					
9- I'm satisfied with the way in which student delegates are elected.					
10- I'm satisfied with my university's website.					
11- I'm satisfied with my university's computer facilities.					
12- The foreign language education is adequate.					
13- The course consultancy system works well.					
14- The environment of the university is clean.					
15- The library opportunities are adequate.					

16- The quality of food is good.					
17- The variety of food in the cafes are adequate.					
18- The sports opportunities are adequate.					
19- The toilets are clean.					
20- Access to the health facility is adequate.					

Using the scale above, how would you rank the overall university experience?

1	2	3	4	5