A Two Step Clustering of Critical Success Factors for Software Development Outsourcing Peculiar to Selected Nigerian Sectors

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Abstract: Software Development Outsourcing, a global IT trend, have gained significant stride in IT business and organizations; aimed at reducing cost, reducing time, and achieving quality in software development projects. The researcher identified four sectors in Nigeria - Banking/Finance sector, Medical/Health Sector, Education sector, ICT sector; the aim of this study is to determine the critical success factors of software development outsourcing peculiar to each of the identified sectors, using a two-step clustering analysis approach. To achieve this aim, the researcher adopted six critical success factors from a prior but related study - Cost Saving and Financial Stability, Effective Communication and Trust, Technical expertise and Knowledge Transfer, Understanding Software Development Outsourcing Industry, Effective Software Privacy and Security, and Overcome Cultural Barrier; and using a two-step cluster analysis, the researchers grouped the six continuous critical success factors around the sectors, to find out the success factor(s) that is/are peculiar and critical to each sector. The result of the analysis indicated that at least two success factors loaded strongly on each sector; thereby contributing strongly to successful software development outsourcing in these sectors. The researcher thus recommends that adequate attention be paid by institutions and firms in these sectors; to those critical success factor that is/are peculiar to each sector in other to be derive maximum success and satisfaction in the quality of software developed for them from the outsourcing firm.

Keywords: Cluster Analysis, Critical Success Factors, Nigeria Sectors, Outsourcing, Software Development

I. INTRODUCTION

Software Development Outsourcing involves contracting out the development, planning, management, training, maintenance or operation of software services, skills, products or applications to a third party firm with the required expertise and skill. Previous research shows that software development outsourcing gained a dramatic increase after 2001 and is still growing continuously due to economic downturn [1].

In the early days of hardware and software development, there was little need for outsourcing [2]. Most projects were in-house, and highly specialized. With timely progress, platforms became more common and companies began focusing more on productivity software. This encouraged the requirements for software development to change. As hardware began to improve, processing capability increased and the level and quality of software it could support also grew. As such competition between software companies with similar products became quite fierce. Instead of having a small dedicated group of programmers on a particular project, software development soon required massive teams just to stay competitive in their market. This led to a significantly increased demand on the work force and a reduction in overall profit [3].

Aim and Objectives

The aim of this research is to analyse, using cluster analysis, the contribution of critical success factors for Software Development Outsourcing to four selected sectors of Nigeria. The specific objectives include:

1.   Identify the critical success factors for successful software development outsourcing in Nigeria.
2.   To cluster these critical success factors around four major sectors of the Nigerian economy that engage in Software development outsourcing
3.   To outline the steps involved in carrying out a two-step cluster analysis

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4.   To outline the benefit of this research to selected sectors of the Nigerian economy.
5.   To make policy recommendation based on the results of the analysis

Research Questions

This research shall be guided by the following questions:
1.   What are the relevant Critical Success Factors that contribute to the success of Software development outsourcing in Nigeria?
2.   Which of these critical success factors is/are specific to software development outsourcing in each identified sector?

Significance of this Research

This research will explore the critical success factors for software development outsourcing peculiar to four identified sectors of Nigeria. The sectors adopted for this research are ICT/Telecommunications sector, Banking Sector, Education sector, and the Healthcare/Medical sector. The findings of this study will contribute to existing literatures on the subject matter by critically examining which factor(s) plays an important role for a successful software development outsourcing in each of the identified sector.

It is also pertinent to note these sectors will benefit immensely from the findings of this study as briefly outlined below:
1.   The ICT and Telecommunications sector will be open to investment opportunities from major players in the ICT industry. This is as a result of the belief that there is now adequate manpower with the right technical know-how in the software industries to develop required software.
2.   The banking sector will benefit from long-term stability of outsourced software and proper policies and documentations guiding this software.
3.   The Education sector is plagued with little or no relevant educational software; as a result, more and more learning activities are carried out in the conventional textbook-classroom manner. Successful software outsourcing will avail this sector with more developed and useful software for learning purposes.
4.   The Healthcare sector will benefit from Expert system software developed under the right conditions, for disease diagnosis and treatment.

This research seeks to prove that outsourcing remains a crucial need for software development to keep pace with emerging organization's need and that it will continue to be a viable option for these sectors well into the future.

II.   CONTRIBUTIONS OF SOFTWARE OUTSOURCING TO NIGERIAN SECTORS

This section analyses the contributions that software outsourcing have had on certain organizations that make up the sub-sectors of the Nigerian economy.

First, it is important to indicate the basic elements in outsourcing [4]:
1.   A large pool of talented and skilled providers
2.   An equally large market of buyers looking for global talent and skill
3.   A mutually agreed compensation package
4.   The existence of the internet as the medium of communication and workspace.

Software development outsourcing will be very beneficial to almost all sectors of Nigerian economy; but most importantly, four (4) sectors will be discussed. As already stated, this study will be centred on these four (4) sectors.

Software Development Outsourcing in Education Sector

Under the education sector, more focus will be given to the tertiary institutions such as the Universities and Polytechnics. Virtually every institution of learning lacks in-house developed software for teaching and administrative purpose.

According to [5], lack of software development knowledge and the pressure to meet deadline are the two major reasons institutions outsource software development. Outsourcing software development to firms with the right expertise and understanding of the software industry, at the right budget will avail this sector – especially higher institution of learning - with quality software for teaching and research needs.

Software Development Outsourcing in ICT Sector

80% of Nigeria's software companies are located in the South of the country; only 20% are found in the North, as shown in Table I. This may reflect economic and educational factors, with the South having higher levels of earnings, literacy and educational attainment than the North [6]. As well as the overall North-South divide, the software industry also appear unevenly distributed by state, with just 14 out of the 36 states plus the Federal Capital Territory (Abuja) registering the presence of a software firm. These firms are found in cities with a bias again towards economic and educational factors, with firms seeming to prefer locations that – while not necessarily best in terms of infrastructure – are commercial hubs where human resources are available.

TABLE I
Software Company Distribution in Nigeria (Soriyan and Heeks, 2007)

Geographic Zone	State	No. Firms	State Percentage	Zone Percentage
South East zone	Imo	1	1%	1%
South South zone	Cross River	2	2%	

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	Delta	4	4%	
	Edo	11	11%	
	Rivers	5	5%	22%
South West zone	Lagos	52	49%	
	Osun	1	1%	
	Oyo	7	7%	57%
North Central zone	FCT/Abuja	4	4%	
	Benue	3	3%	
	Kogi	1	1%	
	Kwara	3	3%	11%
North West zone	Kaduna	3	3%	
	Kano	6	6%	9%
Total	*14 States*	103	*100%*	*100%*

Looking at the current consumer trend in Nigeria, Ojo Maduekwe writes that the country is fast shifting from software-consuming to a software-producing economy. More than before, advancement in information and communications technology (ICT) has continued to determine and reshape the way we live, work and play, greatly influencing and transforming the social media, government, education, culture and the workplace. At the centre of this knowledge revolution is software development. Some parts of the world may have gone ahead in developing their software industry to become better advanced than Nigeria's, but the giant of Africa is working at not being left behind. Once, the country was known for being contented as a consuming technology, but recent events have seen its citizens producing software for local consumption to the point that foreign organisations are investing in the sector [6].

Software development is not a relatively new IT service in Nigeria. Today, Software development has impacted so much in the ICT sector such that it has gathered interest from foreign users and investors alike. Now, companies in the ICT sector are exposed to investments from multinational companies that might need certain software to carry out their business functions. ICT and software development (if properly managed) can be at a forefront of the economy's development.

Software Development Outsourcing in Banking Sector

Software applications are at the heart of virtually all banking transactions that takes place daily. The introduction and use of software have ensured that financial transaction is done with ease; thereby changing the structure of the Nigerian financial services industry [7]. The increasing adoption of ICT enabled tools and technologies further enhance the value of the use of software in banking operations.

The banking sector is also a major beneficial of software development outsourcing. In addition to the various developed software applications used for daily transactions in the bank, most customers also uses the bank's mobile application from the comfort of their homes to send and receive money. This software is usually outsourced to experienced software developers that make this software to suit the needs and requirements of the banks. Outsourcing software development in the banking sector has revolutionized the way business transactions are carried out.

Software Development Outsourcing in Healthcare Sector

The requirements for software and information systems for healthcare institutions in Nigeria differ from those in the industrialised countries in many ways. Local software development, adaptation and organisational implementation are thus highly important. The healthcare sector is one industry touched through software outsourcing. Due to the momentous developments experienced on the area of equipment, healthcare has become one outsourcing-pro sector [7]. Healthcare software development outsourcing is a key facet that can help increase the Return on Investment (ROI) in healthcare facilities. Less time and money will be spent using this developed software as against carrying out billing and other services using so many paper works.

III. RESEARCH DESIGN

The researcher chose an analytical field survey, which is aimed at researching and analysing the critical success factors of software development outsourcing peculiar to four sectors of the Nigerian economy; namely Banking/Finance sector, Medical/Health Sector, Education sector, ICT sector. Both primary and secondary data is used in this research. The secondary data was gotten from related literatures and journals; as well as a prior work carried out by the researchers. The six critical success factors of software development outsourcing for Nigeria are Cost Saving and Financial Stability, Effective Communication and Trust, Technical expertise and Knowledge Transfer, Understanding Software Development Outsourcing Industry, Effective Software Privacy and Security, and Overcome Cultural Barrier [8]. These critical success factors represented as X1, X2, X3, X4, X5, and X6 respectively has been adapted for use in this research. The primary data was generated from administering a well-structure questionnaire, evenly distributed to respondents (comprising academicians, IT experts and other stakeholders in the IT industry) from the four sectors. A total of 200 questionnaires were distributed; with 50 questionnaires evenly distributed to the four sectors.

IV. METHOD OF DATA ANALYSIS

Cluster analysis or clustering is a multivariate technique of grouping a set of objects in such a way that objects in the same group (called a cluster) are more similar (in some sense or another) to each other than to those in other groups (clusters). It is a main task

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of exploratory data mining, and a common technique for statistical data analysis, used in many fields, including machine learning, pattern recognition, image analysis, information retrieval, and bioinformatics. Cluster analysis classifies a set of observations into two or more mutually exclusive unknown groups based on combinations of interval variables. The purpose of cluster analysis is to discover a system of organizing observations, usually people, into groups where members of the groups share properties in common. It is cognitively easier for people to predict behaviour or properties of people or objects based on group membership, all of whom share similar properties. It is generally cognitively difficult to deal with individuals and predict behaviour or properties based on observations of other behaviours or properties. There are three variations of cluster analysis: Hierarchical Cluster Analysis, K-Means Cluster Analysis and Two Step Cluster Analysis.

For the purpose of this research, The Two Step Cluster Analysis is used; which basically combines the ability of Hierarchical and K-Means Cluster Analysis.

The cluster analysis will group the six critical success factors around the four identified sectors, and help us determine which factor(s) is/are peculiar to each sector.

Cluster Analysis Result Interpretations

Cluster analysis does not identify a particular statistical method or model, as do multiple regression analysis or discriminant analysis. Using cluster analysis, we can also form groups of related variables, similar to what we did in factor analysis. There are numerous ways we can sort cases into groups. Cluster analysis is ideal because we intend predicting peculiar groups (clusters) from a set of continuous variables; this differs significantly from discriminant analysis that tends to predict group membership (i.e. discriminating a set of continuous variables between members of a group).

In this research, we have 200 cases categorized into four groups of 50 cases each. Each group represents the four identified sectors of the Nigerian economy. The major purpose of this cluster analysis is to analyse the sectors into clusters and identify one or more critical success factor peculiar to each cluster as collected from the respondents. This can help us make informed decisions and draw logical inference as to which one or more of the success factors is critical to successful software development outsourcing in each of the sectors.

Since we are using both the continuous variables (the 6 critical success factors) and categorical variables (4 identified Nigerian sectors), we shall make use of the two-step cluster analysis procedure.
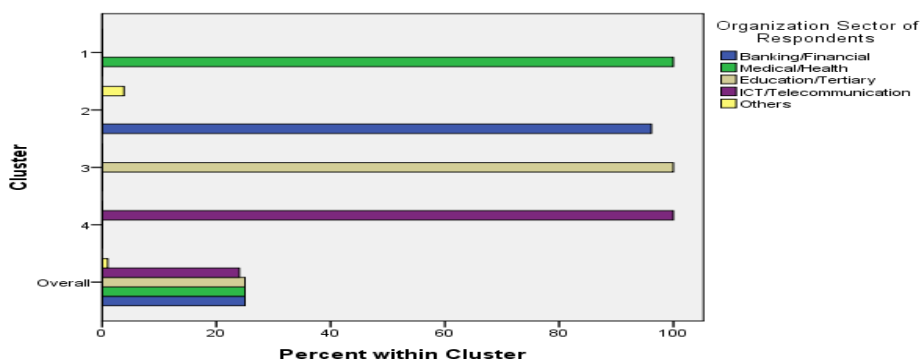
Examining the Number of Clusters

TABLE II
Cluster Distribution

		N	% of Combined	% of Total
Cluster	1	50	25.0%	25.0%
	2	52	26.0%	26.0%
	3	50	25.0%	25.0%
	4	48	24.0%	24.0%
	Combined	200	100.0%	100.0%
Total		200		100.0%

From Table II, clusters 1 and 3 (representing 25% each) have equal number of cluster distribution; while the largest cluster, cluster 2, has 52 distributions representing 26%. A total combined number of 200 cases were involved in the analysis. All cases were included in the cluster formation because they have valid values for all variables.

Examining the Composition of Clusters

Fig. 1: Within Cluster percentage of Organization Sector of Respondents

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Once we have formed clusters, we want to know how they differ. Cluster analysis offers numerous displays and tables to help determine the composition of the clusters and the importance of each variable in determining the cluster.

Fig. 1 shows the percentage of each of the sectors (Banking/Financial, Medical/Health, Education/Tertiary, ICT/Telecommunication) in each of the clusters.

In cluster 1, the distribution of Medical/health is 100% while no other sector contributed to this cluster. What this means is that the **Medical/Health sector** makes up the whole of Cluster 1.

In cluster 2, the distribution of Banking/Financial is 98% while others contributed 2%. The contribution of "Others" is quite insignificant to the cluster; we can therefore infer that the **Banking/Financial sector** makes up the whole of Cluster 2.

In cluster 3, the distribution of Education/tertiary is 100% while no other sector contributed to this cluster. What this means is that the **Education/tertiary sector** makes up the whole of Cluster 3.

In cluster 4, the distribution of ICT/Telecommunication is 100% while no other sector contributed to this cluster. What this means is that the **ICT/Telecommunication** sector makes up the whole of Cluster 4.

Within Cluster Variation

For each continuous variable (Critical Success Factors), we get a plot of the means for each group and simultaneous confidence intervals for the population cluster means.
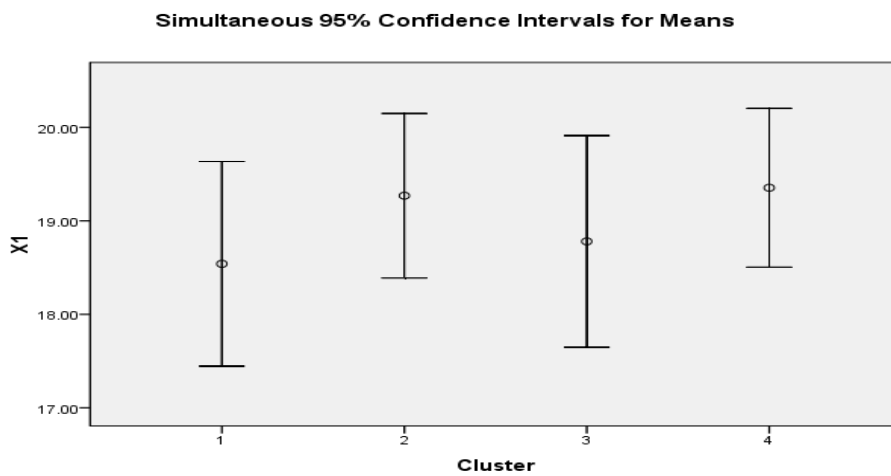

Fig. 2: Within Cluster Variation for Cost Saving and Financial Stability

Fig. 2 indicates that Cost saving and Financial Stability (X1) is Largest in Cluster 4, while its presence can also be felt in Cluster 2.
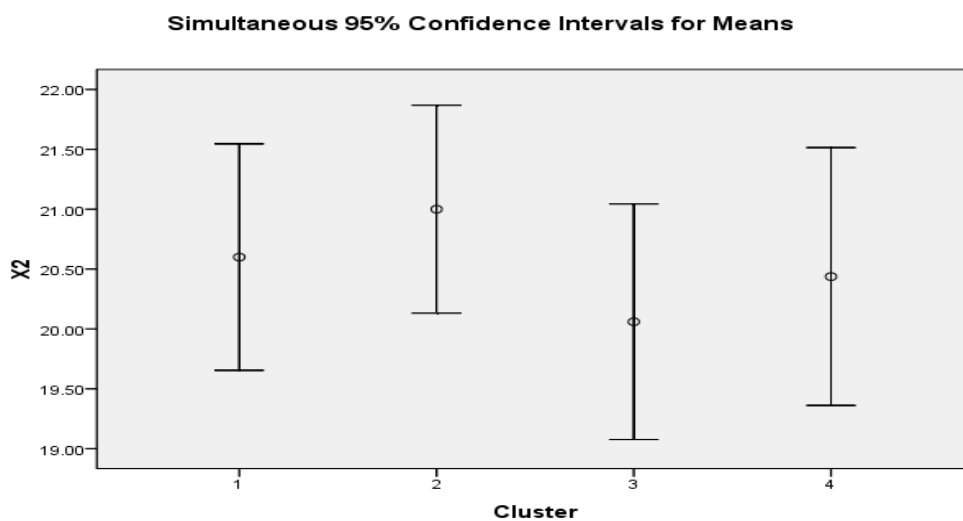

Fig. 3: Within Cluster Variation for Effective Communication and Trust

Fig. 3 indicates that Effective Communication and Trust (X2) is Largest in Cluster 2, while its presence can also be felt in Cluster 1.
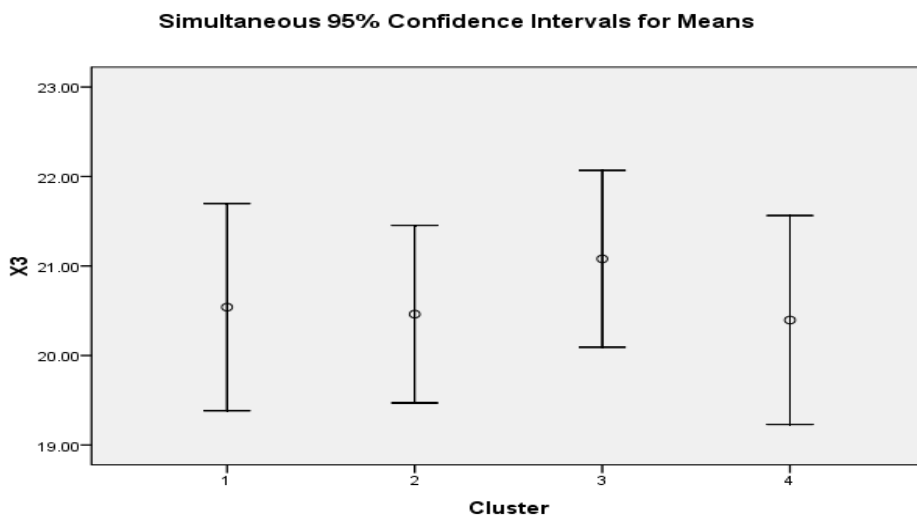
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Simultaneous 95% Confidence Intervals for Means

Fig. 4: Within Cluster Variation for Technical Expertise and Knowledge Transfer

Fig. 4 indicates that Technical Expertise and Knowledge Transfer (X3) is Largest in Cluster 3.

Simultaneous 95% Confidence Intervals for Means
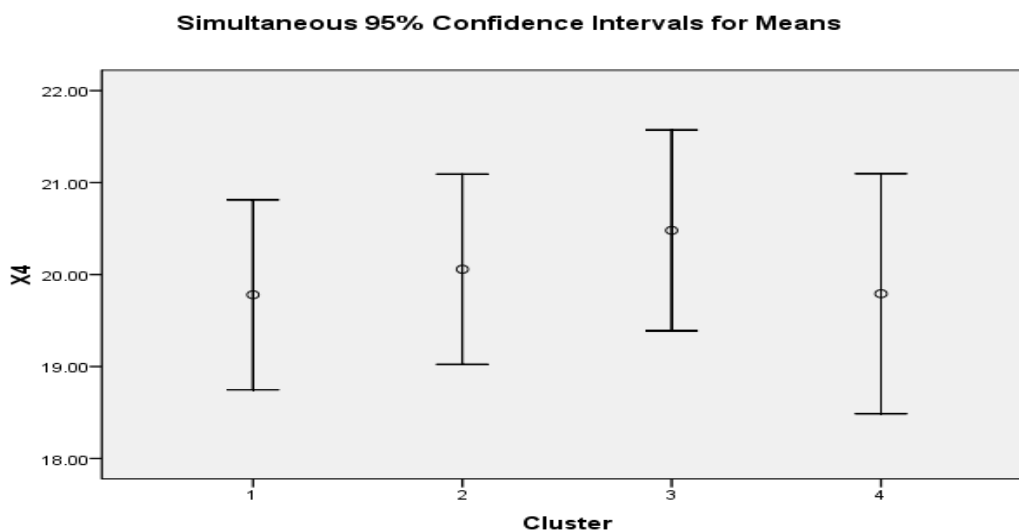

Fig. 5: Within Cluster Variation for Understanding Software Development Outsourcing Industry

Figure 5 indicates that Understanding Software Development Outsourcing Industry (X4) is considerably present in Cluster 3.

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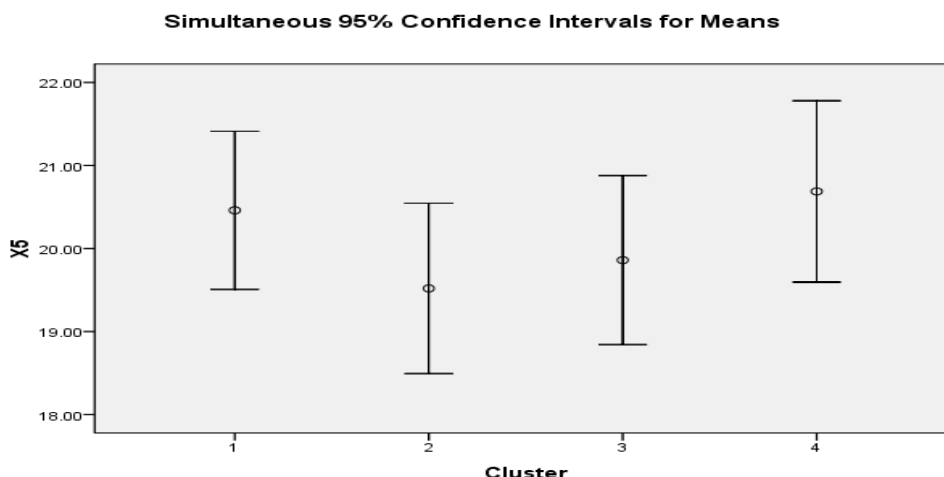*Volume 1 , Issue 6 , Sept. 2016*
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Fig. 6: Within Cluster Variation for Effective Software Privacy and Security

Fig. 6 indicates that Effective Software Privacy and Security (X5) is Largest in Cluster 4, while its presence can also be felt in Cluster 1.
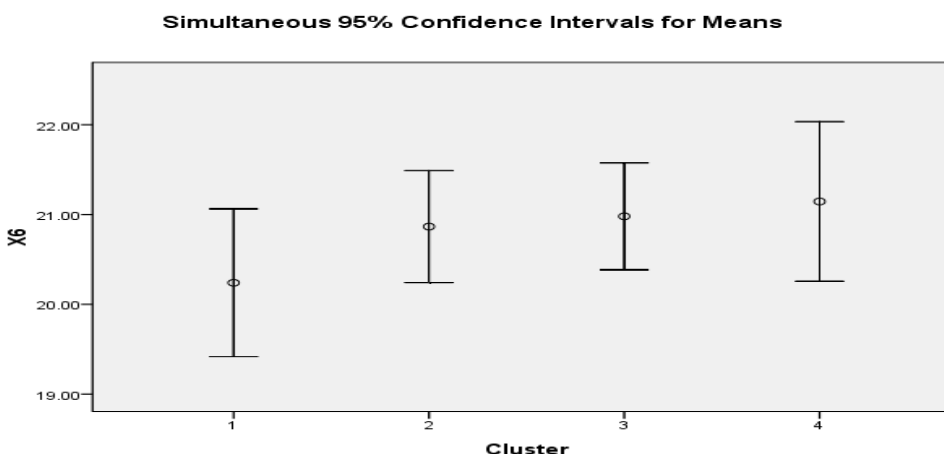

Fig. 7: Within Cluster Variation for Overcome Cultural Barrier

Fig. 7 indicates that Overcome Cultural Barrier (X6) is Largest in Cluster 4, while its presence can also be felt in Cluster 2 and 3.

Examining the Importance of all the Critical Success Factors within a Cluster

Having known our clusters, we now need to find out which critical success factor(s) is/are peculiar to each cluster (sector);
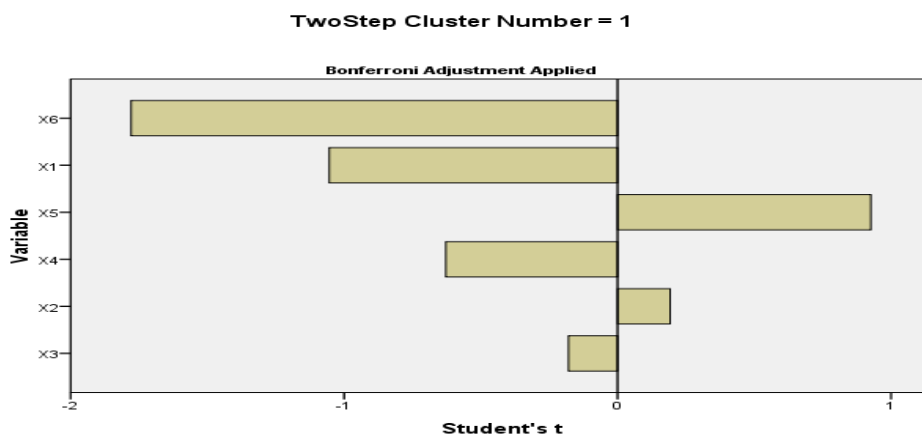

Fig. 8: Continuous Variable wise Importance in Cluster 1

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Fig. 8 shows that all the six success factors were used in forming Cluster 1, but only variables X5 and X2 are critical to the cluster. What this means is Effective Software Privacy and Security, and Effective Communication and Trust are the most critical factors for Medical/health sector to have a successful software development outsourcing. This also tallies with the results we derived in Figure 3 and Figure 6 where cluster 1 loaded very high within those variables.
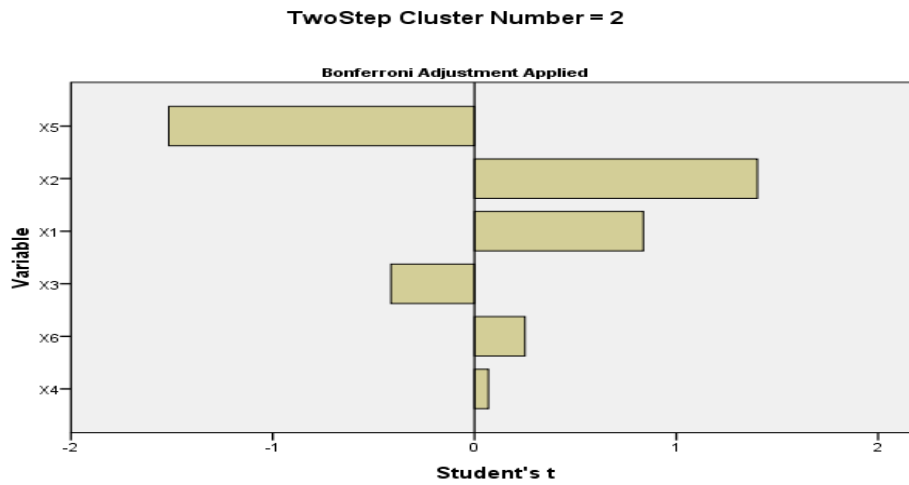

Fig. 9: Continuous Variable wise Importance in Cluster 2

Fig. 9 shows that all the six success factors were used in forming Cluster 2, but only variables X2 and X1 are very critical to the cluster. What this means is Effective Communication and Trust and Cost Saving and Financial Stability are the most critical factors for the Banking/Financial sector to have a successful software development outsourcing. This sector might also want to consider Overcoming Cultural Barrier as a critical factor. This also tallies with the results we derived in Figure 2 and Figure 3 where cluster 2 loaded very high within those variables.
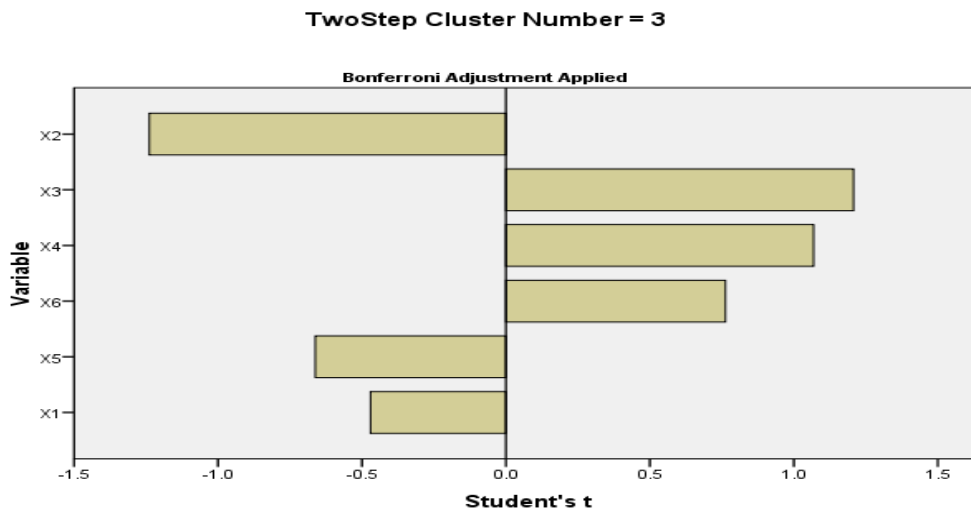

Fig. 10: Continuous Variable wise Importance in Cluster 3

Fig. 10 also shows that all the six success factors were used in forming Cluster 3, but only variables X3, X4 and X6 are very critical to the cluster. What this means is Technical Expertise and Knowledge Transfer, Understanding Software Development Outsourcing Industry and Overcome Cultural Barrier are the most critical factors for the Education/Tertiary sector to have a successful software development outsourcing. This also tallies with the results we derived in Figure 4, Figure 7 and Figure 5 where cluster 3 loaded very high within those variables.

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TwoStep Cluster Number = 4
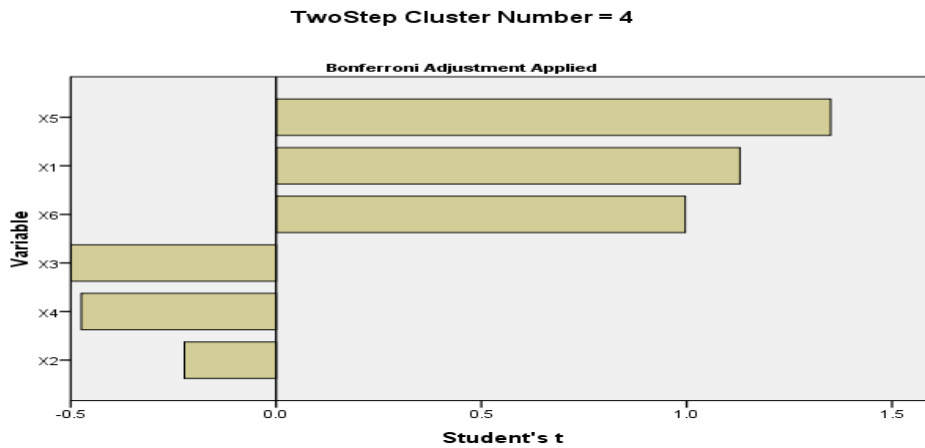
Bonferroni Adjustment Applied

Fig. 11: Continuous Variable wise Importance in Cluster 4

Fig. 11 also shows that all the 6 success factors were used in forming Cluster 4, but only variables X5, X1 and X6 are very critical to the cluster. What this means is Effective Software Privacy and Security, Cost Saving and Financial Stability and Overcome Cultural Barrier are the most critical factors for the ICT/Telecommunication sector to have a successful software development outsourcing. This also tallies with the results we derived in Figure 6, Figure 2 and Figure 7 where cluster 4 loaded very high within those variables.

V.   Result Discussion Based on Research Questions

Results are discussed here in the context of the research questions

1.   What are the relevant Critical Success Factors that have major contribution to Software development outsourcing in these sectors?

From prior related work and as used in this research, the six relevant Critical Success Factors are Cost Saving and Financial Stability, Effective Communication and Trust, Technical expertise and Knowledge Transfer, Understanding Software Development Outsourcing Industry, Effective Software Privacy and Security, and Overcome Cultural Barrier. The result of this analysis shows that these six critical success factors have varying degree of contributions to each of the four sectors.

2.   Which of these success factors is/are critical to the success of software development outsourcing in each identified sector?

As indicated in the result of the cluster analysis, table 3 shows the success factors critical to software development outsourcing in the four identified sectors of the Nigerian Economy;

Table III
Critical Factors for Each Sector

S/N	Sectors	Critical Success Factors
1	Medical/ Health	**Effective Software Privacy and Security** **Effective Communication and Trust**
2	Banking/Financial	**Effective Communication and Trust** **Cost Saving and Financial Stability**
3	Education/Tertiary	**Technical Expertise and Knowledge Transfer** **Understanding Software Development Outsourcing Industry** **Overcome Cultural Barrier**
4	ICT/Telecommunication	**Effective Software Privacy and Security** **Cost Saving and Financial Stability** **Overcome Cultural Barrier**

For Medical/Health Sector, the result of this analysis is in contrast with the work of [9] and [10]; these works identified Cost saving, Time flexibility and Contract fulfilment as factors that contribute to success of software development in this sector. This result is however inconsistent because their research were not centred on the Nigerian economy. Thus, a logical conclusion cannot be drawn from this. Our research focused on Nigeria; hence it gives a correct representation of the factors for successful software development outsourcing in this sector.

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The result from the Banking/Financial sector is consistent with the work of [7]; identifying Trust and budget saving as the factors banks will consider before outsourcing software development to vendors.

Similarly, the result from the Education/Tertiary sector was also consistent with the works of [11] and [5]; identifying Technical Knowledge, Team work, and success in software industry as critical to success of software development outsourcing in this sector.

The study of [6] identified good ICT policy, financial strength and software privacy as consistent with success of software outsourcing in the ICT sector. However, [12] identified Clients participation, training and efficient communication infrastructure as critical to the ICT sector. This study was however conducted with Asia in mind, which isn't in line with the Nigerian environment.

CONCLUSION

Cluster analysis was carried out with four selected sectors in Nigeria using six critical success factors; to identify the factor(s) that is peculiar and that has a major contribution on successful software development outsourcing in the sector. A summary of this analysis is shown in Table 3.

The researcher thus recommends that adequate attention be paid by institutions and firms in these sectors; to those critical success factor that is/are peculiar to each sector in other to be derive maximum success and satisfaction in the quality of software developed for them from the outsourcing firm.

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