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Link Network Search Analysis of Literary Books: The Achebe's

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Abstract
Measures of impact of academic research has considerable attention in the cyber metrics world today that it application becomes very relevant in the evaluation of connectivity of books in the field of literary discipline. This paper considered seven literary books- Things fall apart; No Longer At Ease, Arrow of God; Man of the People; Anthills' of the Savannah; The Trouble with Nigeria and There Was a Country connectivity on the web links using Web Analyst and Pajek Software to draw the network links diagrams based on adaptation of Kamada-Kawai Algorithms and Frutchmann-Reign Gold. The finding confirmed that Achebe literary books have seen much impact and connectivity over the years.
Key words: Graphs-F-R, K-K, Networks, Literary, Achebe, Connectivity, Pajek

1.0 Introduction

Social networking of literary works of great writers have been used to show case the rich culture and dynamism of the white, Arab, Asian and in most Latin American but scarcely in the case of African society especially Nigeria where the teaching and learning of history and literature at the secondary school levels is rare, if not gone in almost extinction. With the advent of computer and internet technology, the teaching, learning and literary works of others have taken a vital position in critical thinking, learning, watching, listening and speaking through entertainments to problem solving modelling theories of intellectual standard and applications (Richard, 2009). In modern society, digital natives and immigrants of earlier scholars, have their voice hard in the social networking environment. Social networking facilities are playing vital role in the web presence and impact reporting of academic and research collaborations despite the geographical differences (Thelwall, 2008). In this paper, we focus attention the link connectivity of literary books written by Achebe and the impact measures nearly 52years till date with the proof of force-displacement of Kamada Kawai movement algorithm.

2.0 Literature Review

In the late 50s through early 60s to late 70s, literary writers in the Nigerian's first generation have written several great piece of work to counteract colonial discourse that misrepresent Nigerian's and Africans in general as "primitive"(Book shy, 2013). These had greater effect on the civilizational and ideologically thinking of our great fore fathers. This has contributed to nearly 61% cultural loss of family system and cohesion with the rich thoughts of the "New" African generation. Undoubtedly, the heats of colonial grace of culture and life style of rural, traditions versus urban and modernity has been affected. From another view point, the male folks have tremendous achievement in literary writing, teaching, entertaining, learning and making of generational writers. Many of these authors are Gabriel Okala, Cyprian Ekwesi, Wole Soyinka, Chinua Achebe, T.M. Aluko, J.P. Clark, Christopher Okigbo and few female play writers- Flora Nwapa, Zulu Sofolas and Mabel Segun whose works were revered as purity and preservatives of cultural and oral dictates and teaching in many senses. Most young generational writers are emerging with reference to older writers whose literary works and books have spoken so much volume of cultural dignity and soul searching in the realm of history and life of one big society "Nigeria". Among these writers, Chinua Achebe seems to have excelled through his work of literary life for his famous quotes that stand the test of time. Though, at the tail end of his life suffered criticism over most controversial titled book "*There Was a Country*". Amidst the wild grudges among the Nigerian elites, he is still considered as the one great African writer, the *Iroko* tree of the black race literary civilization and diffusion across the Africa and the continent beyond. His book, "*Things Fall* Apart", finds enjoyable position within and outside cultural divide and reported to have been translated in nearly 145 languages (the New York Times, 2009 and the Nigerian Guardian, 2013). Björneborn (2004) in his doctoral thesis on small world network link structures across academic web space studied data generated from 109 UK universities. A conceptual framework and empirical methods is designed to identify how small-world emerge in link structures across an academic web space and determine what proportion of micro-structure activities and elements that contribute to the cohesiveness of the macro-structures across an academic web space. The findings verifies that UK academic

websites show Small World Network (SWN) properties with a high clustering coefficient and a low characteristic path length of 3.5 between reachable websites. However, in this study the bases of Small World Networks partly on six degrees separation and power law scheme is characterised in the Achebe literary books search. The choice of the search engine is in line with high suitability relative to other search engines available on the Web using the AltaVista search engine (Thelwall, 2002a; Qiu, Chen, & Wang, 2004). Link analysis is based on the foundational and conceptual theories of (Payne & Thelwall, 2004; Thelwall & Wilkinson, 2005).
Based on the quest for Didactic and Problem Solving Models (DM and PSM) for generational writers and literary readers across the world, it is paramount therefore to study how mathematics and statistics can be applied to establish the rate of connectivity of literary books such as those written by Achebe Chinua - *Things fall apart; Arrow of God; the man of the people; Anthills' of the Savannah; the Man of the People; No longer at ease and there was a country*, and their readership link network search analysis through cyber metrics to evaluate the PSM connection in students logical mind using mathematics and statistics to devise a baseline model for evaluating literary writers in Africa. Given merit of exploits in internet trending Blog, Facebook, Tweeter, Search, Trend, MySpace, Toggle, LinkedIn, Skype, wall sap, you tube e.t.c, neural network search links diagrams using the internet source from archived data is appropriate in this study. Chinua Achebe and his contributions to the world of literature in the Great Black society via Achebe's literary books written since early 60s til- date through readership metrics in the literary world of link network.

3.0 Network Visualisation Theory
The concept of network visualisation is very vital in social networking as it helps to illustrate the pattern of the link sites or title mentions diagrams to show the nature of centrality and cluster coefficient of nodes and arrow in a neural networking of social works. The characteristics of links diagram such as node sizes, colours and arrow widths help to describe and represent information within the designated network environment. To make this possible, social network experts design user friendly interface programme with the concept and principle of graph and discrete mathematics to produce software like Webo Metric Analyst (WMA), Pajek and UCINET to execute network diagrams on the internet. The software also work within the space of online presence and on the background of mathematical and statistical theory. Fretch-Man and Reign-Gold and Kamada-Kawai Algorithms are used (Thelwall, 2012 in Kamada and Kawai, 1989; Fretchman and Reign, 1991). To have a well-defined network diagram with distinct pattern in cyber metrics analysis, less than 50 nodes are recommended (Thelwall, 2013). Mathematical scaling scheme and grouping of similar nodes to avoid overlapping are essential in social network diagrams. The diagrams enable identification of degree centralities which measure in degree, degree and out degree connectivity of a network, diameters, betweenness and closeness centralities of a network; cluster coefficient of individual and group network measures. In addition, the calculation of network concurrent knowledge and performance of isolated, central nodes with the extent of IN, OUT, Strongly Connected (SCC), Tendril and Disconnected network within the dimension of network neighbourhood space are calculated to define and describe network diagram within a social network environment (Thelwall, 2002c). To automatically position node in a neural network definition, Kamada-Kawai and Frutchman-Reign Gold algorithms are most appropriate suggested in 1989. In the study of social network visualisation of Achebe literary books online network node positioning is made using Kamada-Kawai algorithms.
3.1 Theory and Application of Kamada-Kawai algorithm
Kamada and Kawai (1989) observe that the graph of directed network requires displacement which is force-directed, movement and equilibrium through the network stress minimisation. It is called force-directed algorithm because it gets line of similar length connecting to familiar nodes by minimising line crossing to enhance clear picture and network interpretation.
3.2 Mathematics of Kamada-Kawai
Numerical concepts and principles of mathematics of geometry, discrete, calculus and algebraic, Kamada-Kawai operation is based (Kamanda and Kawai, 1989). It also uses cluster classification and local theory.

Mathematically, Kamada-Kawai is expressed as; $$E = \sum_{1 \le i < j \le |V|}^{m} \frac{1}{2} K_{ij} \left(\left| p_i - p_j \right| - l_{ij} \right)^2 \qquad 1$$

Where p_i and p_j are vertice of coordinates position of location within network or links, K_{ij} is the strenghth of the spring from i to j, l_{ij} is the optimal distance between vertices which is proportional to the shortest path between them (See, Thewall, 2009).

$$l_{ij} = L * (d_{ij}) \text{ for } d_{ij} = \sqrt{(x_i - x_j)^2 + (y_i - y_j)^2} \qquad 2$$

Using the concept of Pythagoras theorem of coordinate point measure then, the function below is used to calculate the length of network area displacement as:

$$L = {L_0}/{\max\{d_{ij}\}} \qquad 3$$

The strength of the spring connecting the nodes i to j is defined by the quantity;

$$K_{ij} = {K_0}/{d_{ij}^{\,2}} \qquad 4$$

The constant quantities of L_0 and K_0 are user predefined for implementation or set by the experimental. Conversely, for longer shortest paths is the weaker otherwise the closer for shorter shortest paths.

3.3 Proof of Kamada-Kawai (K-K) Movement of Position Change in the Network

Given the set of positions $p_i = (p_1, p_2, p_3, \ldots p_n)$ and $p_j = (p_1, p_2, p_3, \ldots p_n)$ for $p_{ij} = (x_i, y_j)$ coordinate measuring the single position node location within the network diagram for $i, j = 1,2,3,4,5,6\ldots$ Using the Pythagoras concept for the position coordinates of $p_i = (x_i, y_i)$ and $p_j = (x_j, y_j)$, the distance from p_i to p_j is expressed as:

$$d_{ij} = |p_i - p_j| = \sqrt{(x_i - y_i)^2 + (x_j - y_j)^2} \qquad 5$$

substituting equation (5) in equation (1), we get

$$E = \sum_{1 \le i < j \le |V|}^{m} \frac{1}{2} K_{ij} \left(\sqrt{(x_i - y_i)^2 + (x_j - y_j)^2} - l_{ij} \right)^2 \qquad 6$$

expanding the quantity in equation (6) by the key of algebraic not perfect square approach $(a-b)^2 = (a-b)(a-b) \rightarrow a^2 - 2ab + b^2$ gives the expression;

$$E = \sum_{1 \le i < j \le |V|}^{m} \frac{1}{2} K_{ij} \left[(x_i - x_j)^2 + (y_i - y_j)^2 \right] + l_{ij}^{\,2} - 2 l_{ij} \sqrt{(x_i - y_i)^2 + (x_j - y_j)^2} \qquad 7$$

taking the partial derivatives of E wit respect to x_m and y_m respectively where $i = m$ and applying function of a function or chain rule derivatives as in $w = (ax + y)^2$, $u = ax + y$, $w = u^2$, $dw/dx,\ du/dx,\ and\ dw/dx = (dw/dx)(du/dx)$ the below expressions are obtained;

$$\partial E / \partial x_m = \sum_{i \ne m} K_{m,i} \left[(x_m - x_i) - \frac{l_{m,i} (x_m - x_i)}{\sqrt{(x_m - x_i)^2 + (y_m - y_i)^2}} \right] \qquad 8$$

Similarly

$$\partial E / \partial y_m = \sum_{i \ne m} K_{m,i} \left[(y_m - y_i) - \frac{l_{m,i} (y_m - y_i)}{\sqrt{(x_m - x_i)^2 + (y_m - y_i)^2}} \right] \qquad 9$$

squaring and summing the partial derivatives of $\partial E / \partial x_m$ and $\partial E / \partial y_m$ of the movement displacement energy results in the total energy minimisation in the spring; $\Delta_m = \left(\partial E / \partial x_m \right)^2 + \left(\partial E / \partial y_m \right)^2 \qquad 10$

plugging in the quantities in equation 8 and 9 in equation 10 and expanding the function results in equation 11 and 12.

$$\Delta_m = \left(\sum_{i \ne m} K_{m,i} \left[(x_m - x_i) - \frac{l_{m,i} (x_m - x_i)}{\sqrt{(x_m - x_i)^2 + (y_m - y_i)^2}} \right] \right)^2 + \left(\sum_{i \ne m} K_{m,i} \left[(y_m - y_i) + l_{ij}^{\,2} - \frac{l_{m,i} (y_m - y_i)}{\sqrt{(x_m - x_i)^2 + (y_m - y_i)^2}} \right] \right)^2 \qquad 11$$

$$\Delta_m = \left(K^2{}_{m,i} \left[(x_m - x_i)^2 - \frac{2l_{m,i}(y_m - y_i)}{\sqrt{(x_m - x_i)^2 + (y_m - y_i)^2}} + \frac{l^2{}_{m,i}(x_m - x_i)^2}{(x_m - x_i)^2 + (y_m - y_i)^2} + K^2{}_{m,i}[(y_m - y_i)^2 - \frac{2l_{m,i}(y_m - y_i)}{\sqrt{(x_m - x_i)^2 + (y_m - y_i)^2}} + \frac{l_{m,i}(x_m - x_i)^2 + (y_m - y_i)^2}{(x_m - x_i)^2 + (y_m - y_i)^2}] \right] \right)^2 \quad 12$$

factoring out $K^2{}_{m,i}$ and reducing the function by applying lowest commonest multiple gives;

$$\Delta_m = K^2_{m,i} \left[(x_m - x_i)^2 + (y_m - y_i)^2 - \frac{2l_{m,i}(x_m - x_i) + (y_m - y_i)}{\sqrt{(x_m - x_i)^2 + (y_m - y_i)^2}} + \frac{l^2{}_{m,i}(x_m - x_i)^2 + (y_m - y_i)^2}{(x_m - x_i)^2 + (y_m - y_i)^2} \right] \quad 13$$

substituting $d_{ij} = |p_i - p_j| = \sqrt{(x_i - y_i)^2 + (x_j - y_j)^2}$ and set of linear equations, we get

$$\Delta_m = K^2_{m,i} \left[[d_{ij}^2] - \frac{2l_{m,i}(x_m - x_i) + (y_m - y_i)}{[(x_m - x_i)^2 + (y_m - y_i)^2]^{1/2}} + \frac{l^2{}_{m,i}[d_{ij}^2]}{(x_m - x_i)^2 + (y_m - y_i)^2} \right] \quad 14$$

$$\Delta_m = K^2{}_{m,i}[d_{ij}^2] - 2l_{m,i} + \frac{l^2{}_{m,i}[d_{ij}^2]}{[d_{ij}^2]} \quad 15$$

cancelling out and rearranging the equation (15), set of quadratic equation is obtained $\Delta_m = K^2{}_{m,i}[d_{ij}^2] - 2l_{m,i} + l^2{}_{m,i}$ and $\Delta_m = l^2{}_{m,i} - 2l_{m,i} + K^2{}_{m,i}[d_{ij}^2]$ as similarity of the set of equations $\Delta_m = l^2{}_{m,i} - 2l_{m,i} + K^2{}_{m,i}\sqrt{|p_i - p_j|}$

and

$$\Delta_m = l^2{}_{m,i} - 2l_{m,i} + K^2{}_{m,i}[(x_m - x_i)^2 + (y_m - y_i)^2]^{1/2} \quad 16$$

However, either of the expressions in equation 16 holds through for $\Delta_m = l^2{}_{m,i} - 2l_{m,i} + K^2{}_{m,i}[(x_m - x_i)^2 + (y_m - y_i)^2]$ In applying the algorithm the user friendly interface embedded Webo Metric Analyst and Pajek social network software will be implemented to draw the network link diagrams of title mention of the Achebe's seven identified literary books- *Things fall apart; No Longer At Ease, Arrow of God; Man of the People; Anthills' of the Savannah; The Trouble with Nigeria and There Was a Country* systematically retrieved from the archive of the AltaVista search engine data web for links network. Web Analyst and Pajek Software to draw the network link diagrams.

4.0 Web Analyst and Pajek Software Procedure

The followings are the procedural approach to executing the Pajek network software for title mention Achebe literary book using the internet base system:

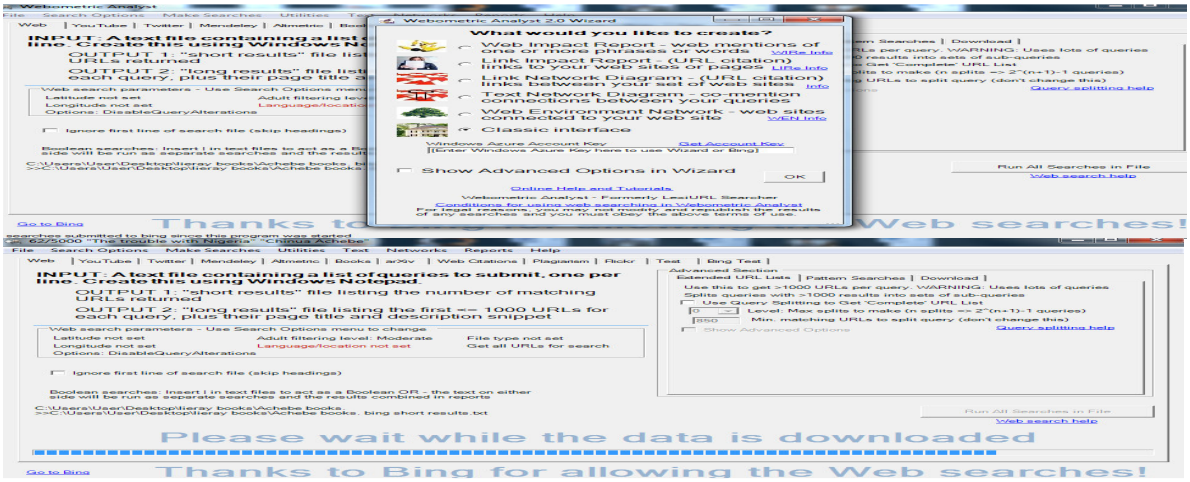
Step1: *Run window based Webometric Analyst software*
Step2: *Upload the pseudo file from Notepad in design folder in a location of your choice*
Step3: *The analyst runs and generates bing result from the archive of the AltaVista search engine data web*
Step4: *For web report click on run selection and upload the long bing result and report on the software to generate report*
Step5: *Load PAJEK in the Webometric Analyst environment select file on the menu and uploadthe long bing NET.file to execute the title mention to run link diagram search of Achebe literary books*
Step6: *Apply K-K Algorithms with F-R network layout to enable node positioning and pattern link smoothening. See programme pseudocode in appendix*

5.0 Methodology

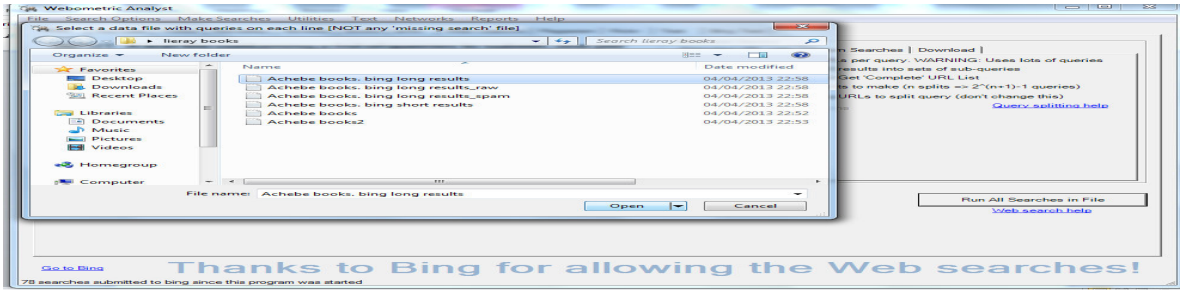
All the Achebe's seven identified literary books- *Things fall apart; No Longer At Ease, Arrow of God; Man of the People; Anthills' of the Savannah; The Trouble with Nigeria and There Was a Country* are systematically retrieved from the archive of the AltaVista search engine data web links using Web Analyst and Pajek Software to create network diagrams. Kamada-Kawai Algorithms spring movement by position and also use to carry out the linking patterns of Achebe literary book online (See Tang and Thelwall, 2003) patterns for university department interlinking. Bowtie concept of Web search structure is used to establish the link connectivity strength of the literary books.

The Web metric Analyst and Pajek Implementations with Kamada-Kawai Algorithm

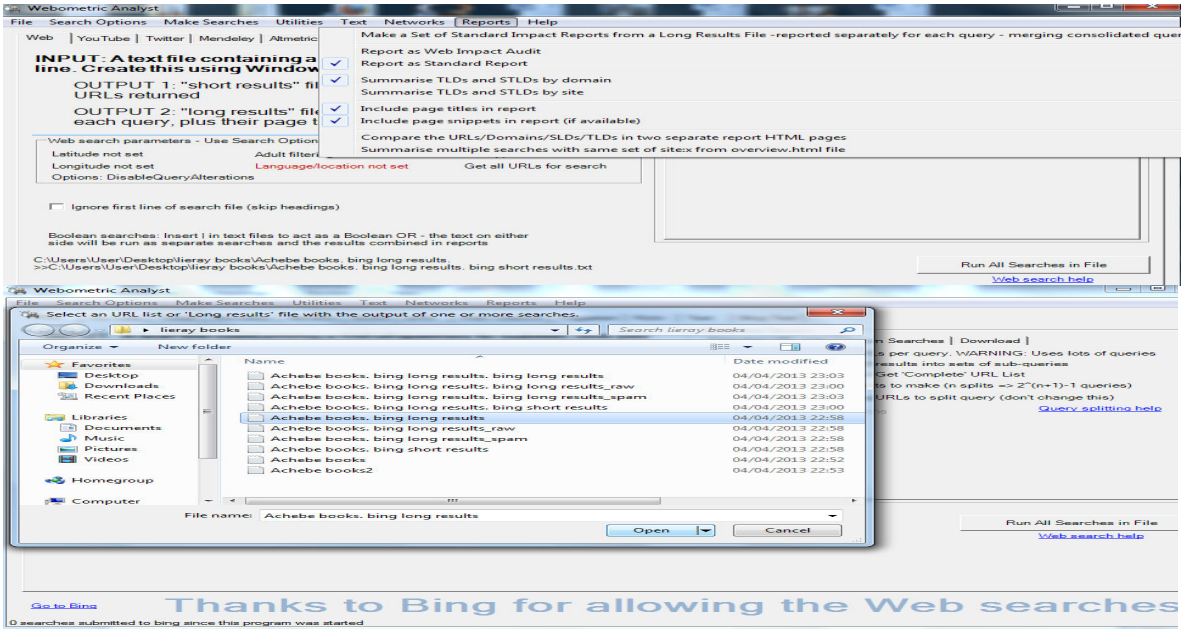
Interface 1



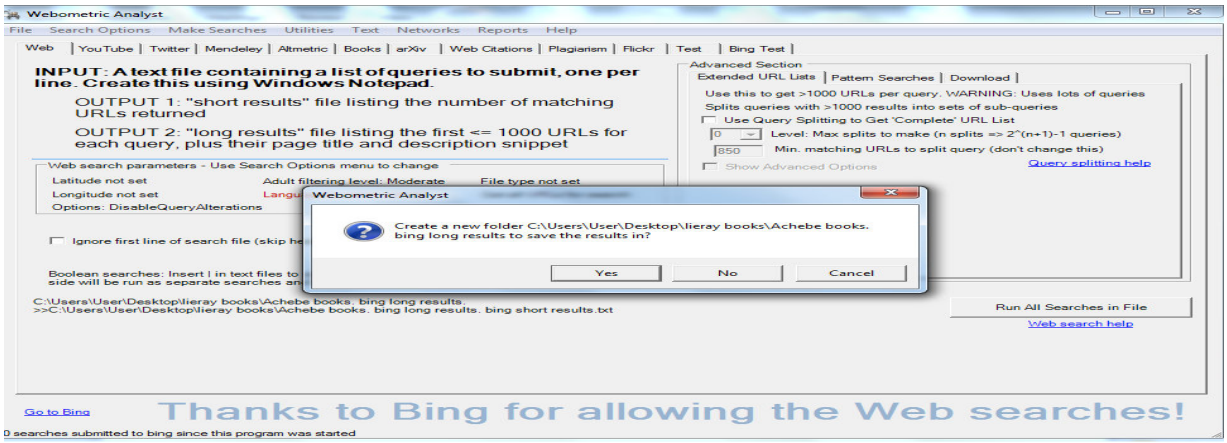
Interface 2



Interface 3



The Execution Interface 4



6.0 The Link Diagram Algorithms

*Vertices 7

1 "'No longer at ease'" ellipse ic red x_fact 10.0 y_fact 10.0
2 "'Arrow of God'" ellipse ic red x_fact 9.3 y_fact 9.3
3 "'A Man of the People'" ellipse ic red x_fact 10.0 y_fact 10.0
4 "'Things fall apart'" ellipse ic red x_fact 9.4 y_fact 9.4
5 "'There was a country'" ellipse ic red x_fact 9.9 y_fact 9.9
6 "'Antihills of the Savannah'" ellipse ic red x_fact 5.5 y_fact 5.5
7 "'The trouble with Nigeria'" ellipse ic red x_fact 10.0 y_fact 10.0

*Edges

1 2 9.8 c Black
1 3 9.5 c Black
1 4 9.6 c Black
1 5 9.7 c Black
1 6 3.8 c Black
1 7 8.7 c Black
2 1 9.8 c Black
2 3 8.9 c Black
2 4 10.0 c Black
2 5 9.1 c Black
2 6 4.0 c Black
2 7 8.7 c Black
3 1 9.5 c Black
3 2 8.9 c Black
3 4 9.7 c Black
3 5 8.3 c Black
3 6 4.1 c Black
3 7 8.8 c Black
4 1 9.6 c Black
4 2 10.0 c Black
4 3 9.7 c Black

Results of Title Mention Network Analysis

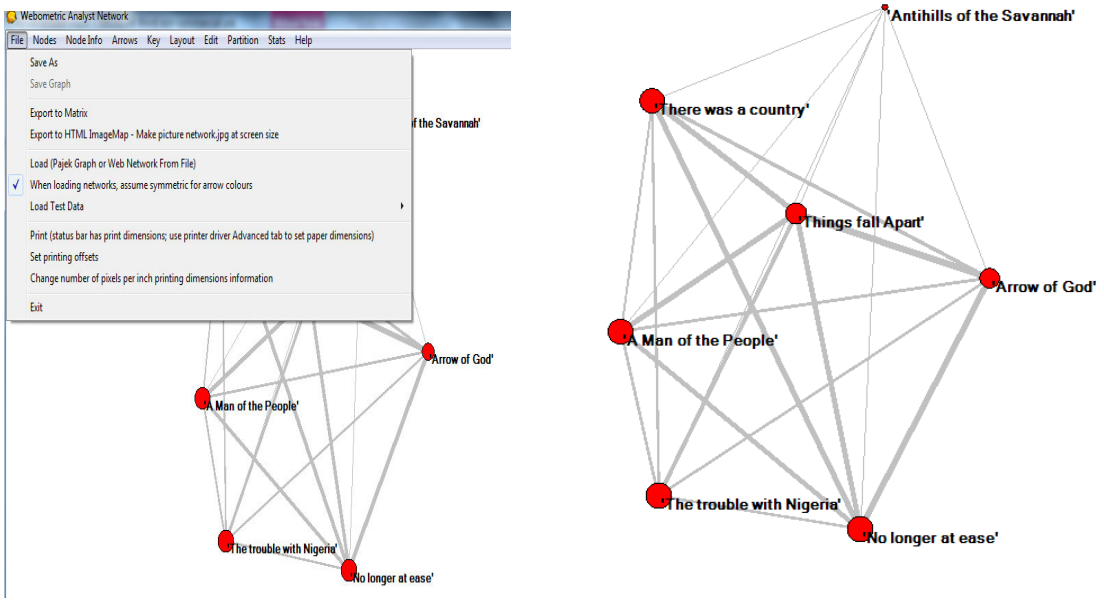


Fig. 1

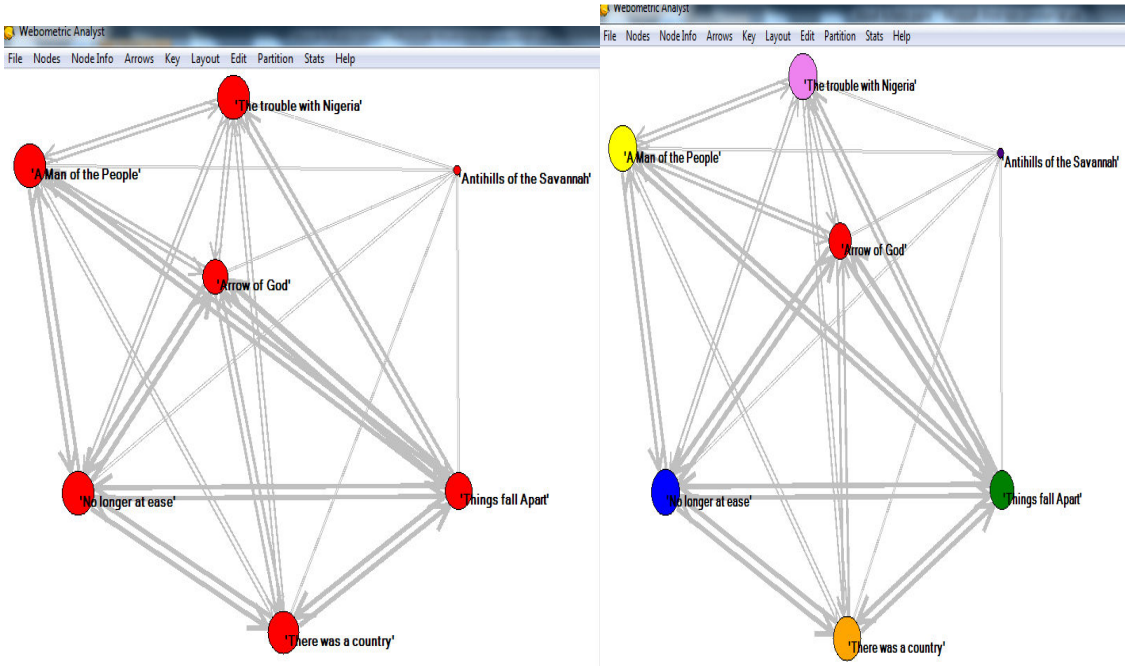


Fig. 2 **The Frutchmann-Reign Gold Smoothing**

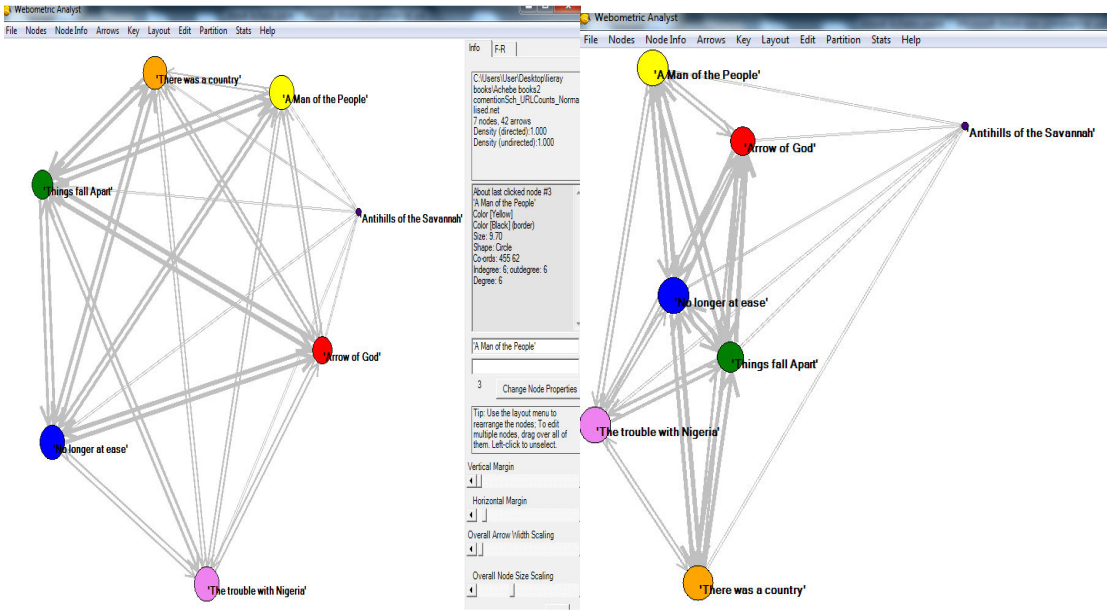


Fig. 3

The network links of the literary books authored by Achebe over the years have extracted and networked with the use of PAjek and Webometric Analyst. The F-R layout smoothing of network nodes, arrows and patterns results in the below bowtie-like diagram.

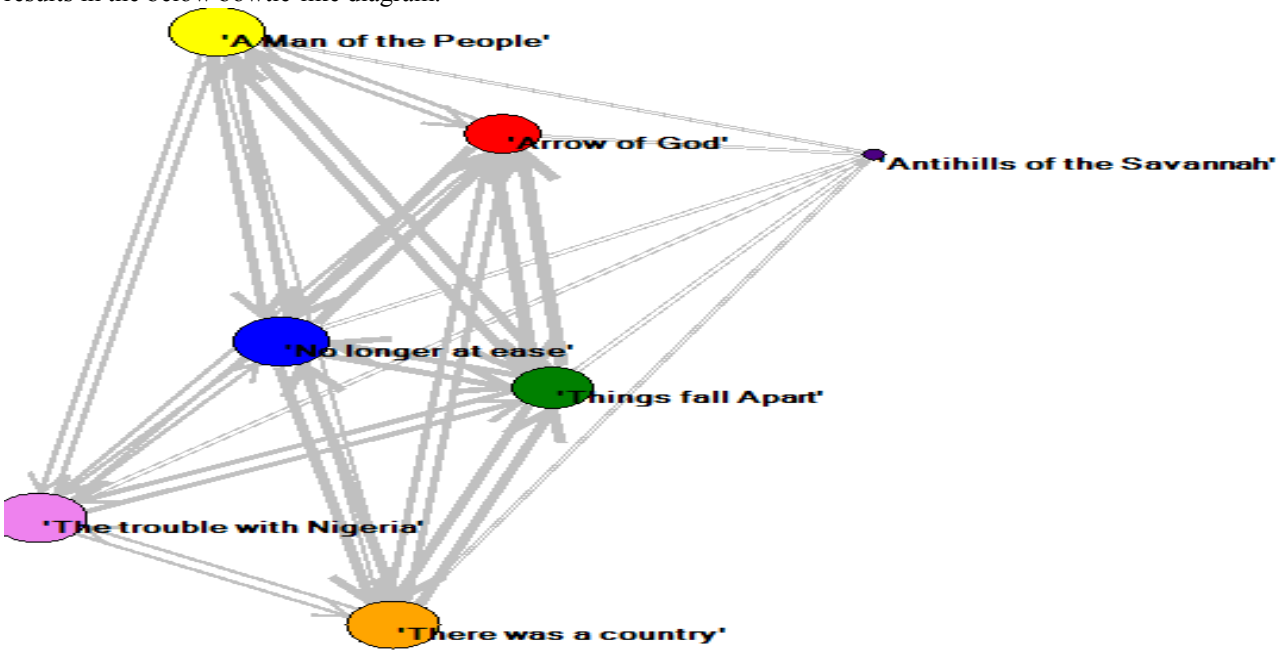


Fig.4 Links Network of Achebe Literary Books Diagram Discussion

Conclusion and Recommendation

From the network diagrams, the final smooth diagram reveals that the *The Man of the People* and *No Longer at Ease* are the most central nodes with the *Things Fall Apart* having the betweennes centrality. *The Trouble with Nigeria* has low link connectivity in the network especially to *There Was a Country*. *Arrow of God* and *A man of the People* have fairly connection with each other. *Antihills of the Savannah* possesses the highest degree of disconnections among the Achebe's library on the Alvista archival web link and web search reference. *The Man of the People*, *No Longer at Ease* and *Things Fall Apart* are considered by the study as the most widely read Achebe literary books over time. This study has empirically shown why Achebe's literary is viewed as the most paraphrased in the literary world. In addition, it serves as baseline model for evaluating literary writers in Africa and the world beyond taken advantage of internet trending social network links and scree network diagrams of

books connectivity for prediction of readership through cyber metrics and mathematical modelling of neural network of authorship.

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References

Björneborn, L. (2004). *Small world link structures across an academic web space: A library and information science approach*. Phd theisis. Department of Information Studies, Royal School of Library and Information Science, University of Copenhagen.

Bookshy (2012). 52 years of Nigerian literature: First Generation; An African book lover; posted on Blog: TwitterShared to Facebook at 11.09 Thursday 28 March 2013.

The Guardian Newspapers (2013). The time and life of Chinua Achebe, the African literary Icon gone literature: the roots and literary documentary broadcasted on the BBC, New, 11 pm March 28, 2013 WMF London, UK.

The New York Time Magazines (2009). Evaluating the African literature: the roots and literary documentary broadcasted on the 11 pm BBC, New, 2013 WMF London, UK.

Nwagwu, Williams E., & Agarin, Omoverere (2008). "Nigerian University Websites: A Webometric Analysis" *Webology*, [online]. **5**(4), Article 62. [Accessed 26 March 2013]. Available at: http://www.webology.org/2008/v5n4/a62.html

Q Qiu, J., Chen, J., & Wang, Z. (2004). An analysis of backlink counts and Web Impact Factors for Chinese university websites. *Scientometrics* 60(3), 463-473

Richards, P. and Elder, L (2006) *Learning to think through: a guide to critical thinking and reflective writing across the curriculum*: 3rd ed. Pearson Prentice Hall, NY. USA.

Tang, R., & Thelwall, M. (2004). Patterns of national and international web inlinks to US academic departments: An analysis of disciplinary variations. *Scientometrics* [online]. **60**(3), 475-485. [Accessed 26 March 2013]. Available at: http://link.springer.com/article/10.1023%2FB%3ASCIE.0000034388.70594.cc

Thelwall, M. (2002a). A comparison of sources of links for academic web impact factor calculations. *Journal of Documentation* [online] 58, 60-72. [Accessed 26 March 2013]. Available at: http://www.scit.wlv.ac.uk/~cm1993/papers/2001_Extracting_macrosopic_information_from_web_links.pdf

Thelwall, M. (2002c). An initial exploration of the link relationship between UK university websites. *ASLIB Proceedings* [online] 54(2), 118-126. [Accessed 26 March 2013]. Available at: http://www.emeraldinsight.com/journals.htm?articleid=863949&show=abstract

Thelwall, M. (2004). Link analysis: An information science approach. Amsterdam: Elsevier [online]. [Accessed 26 February 2013]. Available at: http://linkanalysis.wlv.ac.uk/

Thelwall, M., Harries, G., & Wilkinson, D. (2003). Why do web sites from different academic subjects interlink? *Journal of Information Science* [online]. 29(6), 453-471. [Accessed 26 February 2013]. Available at: http://jis.sagepub.com/content/36/6/671.full.pdf+html

Thelwall, M., & Wilkinson, D. (2005). Three target document range metrics for university web sites. *Journal of the American Society for Information Science and Technology* [online]. 54(6), 489-496. [Accessed 16 March 2013]. Available at: http://www.eicstes.org/EICSTES_PDF/PAPERS/Three%20Target%20Document%20Range%20Metrics%20for%20University%20Web%20Sites%20(Thelwall).pdf