A Collaboration Index for Research Institutions

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Abstract— **Research institutions are organizations that focus on learning, teaching, research and development. In this article indices are used to identify key elements for management to focus on and thereby act as measurements for establishing potential growth of research institutions.**

Electronic collaboration also known as "e-collaboration" has become synonymous with working online and on the Internet. Furthermore with the advent of social media, websites are also considered an important and central platform for collaborating.

This article considers e-collaboration as a form of innovation hence the focus on the diffusion of innovations (DOI) theory.

While the Journal Impact Factor (JIF) measures the frequency with which an article in a journal is cited, the e-collaboration index will be an indicator of how easy it will be for collaboration to take place with a research institution. The index can also link potential collaborators to existing initiatives on the website.

The literature will discuss the connection between collaboration, indices and the use of matrices.

The methodology used in the article featured questionnaires with data being collected from websites of research institutions. The rationale and supporting theories are introduced as foundational and motivation for the index development.

Analysis was done using the coding method. The final outcome for the article features a basket of factors. The developed collaboration index is detailed followed by relevant discussions and the potential improvement areas.

Once implemented, an e-collaboration index level can be calculated by the research institution.

Keywords-component; Collaboration, index, matrix and research institutions.

I. INTRODUCTION AND BACKGROUND

This article adopted the index analogy that is commonly used in the finance and the investment community. The analogy is developed under the theme of collaboration. The development of this index aims to enable the tracking of collaboration initiatives by research institutions. This article considers the development of an index for research institutions as an innovation that requires further investigation.

The purpose of developing an index is to continue in the advancement and address challenges of collaboration as discussed by multiple authors cited in the section to follow.

There is a "use boundary" is critical to expanding e-collaboration which relates to the act of using any systematic changes expectations of what and should be supported [9].

There is a lack of sharing resources necessary to facilitate cooperative teaching; thus the possibility of an academia-service gap is increased [20]. With sharing researchers collaboration can be improved.

In an investigation by [15], it is noted that the vast majority of respondents used the open web for academic and research purposes. This supports the idea that technology is used for conducting research and more specifically the web.

Dynamic or interactive web pages that are dedicated to research are listed as one of the websites fundamentals for e-collaboration among research institutions [10]. This is further evidence on the common use of technology and more specifically websites.

There is more that can be done on e-collaboration leading to the improvement of research institutions [12].

Twitter can be a means of communication with members of educational community [5]. Academics are making use of social networks in their work and collaboration efforts.

The authors above have indicated the main focus on web technologies. This is is demonstrating the importance and significance of web sites as a common platform for collaboration by academics and researchers.

The above authors have further shared thoughts and output on technology use in academia which support this article.

The structure of this article begins with listing the objectives then the literature together with the supporting theory is discussed. The methodology, finding, discussions, future works and conclusion complete this article.

II. THE ARTICLE'S OBJECTIVES

The objectives for this article are featured in the discussion from the preceding section. Further objectives include the following:

- To investigate ideas of e-collaboration, research institutions and supporting theory;

- To discuss the concepts for measuring, matrices and impact factors;

- To design an e-collaboration index for research institutions; and

- To share thoughts on the usefulness and future use of the developed index.

It is important to note that although the article features quantitative measures and values, the primary objective is intended to be more qualitative in nature.

III. COLLABORATION AND COMPLEMENTARY ELEMENTS

The main foundation of this article's literature is on collaboration, e-collaboration, research institutions, open access and the supporting theories.

A. Collaboration explored

Collaboration is considered as working together by more than one person with a common outcome. This is supported in an early definition by [14] describing collaboration as a mutually beneficial and well-defined relationship entered into by two or more organizations to achieve common goals. The aim to achieve common goal is also relayed by [26].

South Africa (SA)'s collaborative approach is to developing the ICT sector and creating a skilled society capable of leveraging technology for the benefit of society at large [4]. This statement supports the importance of collaboration for governments.

B. E-collaboration as a base

This article begins by adopting the commonly used, basic, simple and effective definition by [9] which describes an interaction of *individuals engaged in a common task using electronic technologies*. The definition that encapsulates the objectives for this article refers to *collaboration that occurs any time where there are two or more people sharing complex information and knowledge-building over the Internet* [6]. These definitions will guide the article in sections to follow.

E-collaboration emerged with the advent of new and improving technologies. The use of technology is central in communication today.

The importance of a National Champions Board in a collaborative project model is also cited by [13]. These are described as key individuals from different spheres who will advise and support the project throughout their various networks. The concept of a champion is therefore adopted and used in this article as a central point of contact for the collaboration index at that research institution.

Researchers access the Web for academic and research purposes from multiple locations [15]. They also noted that academics use several search engines to find information for academic and research purposes. This supports the idea that technology is being used by researchers in their daily work.

C. Research institutions as fertile ground

"*Research institutions are a fertile ground for theory advancement since their core focus is on academic work and research*". [12] This article considered this and was motivated to continue and include research institutions as one of the key areas. Research institutions are therefore important in providing a good platform for knowledge development and innovation.

The Academy Of Science [2] classified universities into three categories: University, Comprehensive University, and University of Technology. Statutory research bodies and research funding institutions are also included since they also conduct research. Research institutions continue to collaborate among themselves, with private and government organisations.

D. Online access to research output

There are a number of ways that research institutions enable access to their publications online.

[3] Noted as one of the leading scientific and technology research, development and implementation organisations in Africa. They further indicate that Researchspace is a database that provides access to research outputs generated by scientists at the CSIR. A website visitor can search through the available publications.

[24] supports the idea of publications through their UJDigispace initiative which they describe as an institutional repository. They further indicate that this is a digital service that collects, preserves, and distributes digital materials.

[25] extends this initiative by presenting a Webometrics Report which lists the top 10 viewed or downloaded electronic documents. This can also assist in establishing potential for collaboration.

The recent launch of a digital open repository by [23] allowing open access to knowledge in the sciences and humanities is also another initiative towards allowing online access to research output

The two institutions cited above implemented their online access to research output interfaces differently. The commonality is that website visitors can be able to navigate through the publications. Both sites allow a website visitor to search using the following: communities and collections, by issue date, authors, titles and subjects. These search options become a standard navigation method. Another standard feature is the ability to register and receive email notifications for updates in your area or interest theme. Online journals also allow users to sign up for article alerts; this confirms that this function is commonly used [21].

While publishing on the websites of these research institutions is limited to staff and students, it still enables other researchers to have access to the publications online.

E. Theory for e-collaboration

In founding this article a theoretical dimension is explored through the lens of diffusion of innovation (DOI).

While discussing the theory on DOI, [17] indicates that diffusion is planned and can also happen spontaneously. For the purpose of this article indices will be introduced and their diffusion will be guided by mechanisms to popularize them through publications as mediums for dissemination. The innovation can further be sustained by early participants.

The table below demonstrates how this article relates with the DOI theory as discussed by [17].

TABLE I.   DOI LENS ON E-COLLABORATION AND INDICES

Element name	Description by [17]	Practical translations on e-collaboration
Innovation	*An idea, practice, or project that is perceived as new by an individual or other unit of adoption.*	* E-collaboration technologies. * A new index is to be developed
Communication channels	*A process in which participants create and share information with one another in order to reach a mutual understanding.*	* The Internet or websites of research institutions. * Other electronic means of communication will be explored
Time	*The impact and dimension of time on the diffusion.*	* This relates to the amount of time it takes for the collaboration initiatives take to be implemented. * The time it takes for an index to be developed and adopted by a wider community.
Social system	*A set of interrelated units engaged in joint problem solving to accomplish a common goal.*	* This is primarily amongst academics, researchers and students.

IV.   MEASUREMENTS, MATRICES AND IMPACT FACTORS

This section will feature the main elements regarding indices and other supporting literature to provide foundational thoughts and ideas to be addressed later in the article.

A. Defining and describing an index

Indices are used primarily in finance and investments. They feature mainly in discussions regarding markets. Concepts such as measure, impact, factor and compare are commonly used when discussing indices.

According to [1] an index of stocks is a compilation of stocks constructed in such a manor to track a particular market, sector, commodity, currency, bond or other asset. They further indicate that stocks in an index are collected in a basket. Shares are subsequently purchased in the index basket.

Investopedia (2013) indicate that an index is a statistical measure of the changes in a portfolio of stocks representing a portion of the overall market. [7] further asserts that since it would be difficult to track every single security trading in a country a smaller sample is taken to represent the whole or population.

The definitions show how indices are investigated, developed, organized and can be implemented over a period of time.

B. Journal Impact Factor

In the theme of academia the Journal Impact Factor (JIF) is central and commonly used by journals.

According to [18] a JIF provide quantitative tools for evaluating journals. This is a measure of the frequency with which the average article in a journal has been cited in a given period.

A comprehensive JIF definition [8]:

"*A measure reflecting the average number of citations to articles published in journals, books, patent document, thesis, project reports, news papers, conference/ seminar proceedings, documents published in internet, notes and any other approved documents. It measures the relative importance of a journal within its field, with journals of higher journal impact factors deemed to be more important than those with lower ones. Journal Impact factors are calculated yearly/half- yearly/ Quarterly/Monthly for those journals that are indexed in Journal Reference Reports (JRR).*"

According to [22] the CA-A Cancer Journal for Clinicians has posted the highest JIF in the JCR Science Edition in 2010 with a JIF of 87.925. There are varying comments in a discussion on JIF.

[21] provides a formula for the global impact factor in the example below:

*   A = the number of times articles published in 2009 and 2010 were cited by journals during 2011.
*   B = the total number of 'citable items' published by this journal in 2009 and 2010. *Citable items* are listed as articles, reviews, proceedings or notes; not editorials or letters to the editor.
*   2011 impact factor = A/B.

The formula for calculating the JIF is addressed by [18] and displayed in the table to follow. Calculating the JIF

TABLE II.   CALCULATING THE JIF

Formula and details according to [18]	Journal A	Journal B
A = the number of times articles published in 2011-2012 were cited in indexed journals during 2013	30	40
B = the number of articles, reviews, proceedings or notes published in 2011-2012	40	50

Formula and details according to [18]	Journal A	Journal B
Impact factor 2013 = A/B	0.75	0.8

This is similar to the one used by SAJIM detailed earlier. An example of the calculation of JIF for 2013 is also provided in the same table.

The *JIF calculation* introduced earlier with sample values in the above table indicates that journal-B has a higher JIF than Journal A. This can be translated and used for multiple reasons by different participants as indicated below:

- A researcher can use this to decide publishing with journal B instead of A;
- Another researcher can be motivated to include this journal's publication in his or her citations or as a reference because of the higher JIF score; and
- Another researcher can be motivated to send through their article to journal A since they could be interested in having articles published with a popular journal.

The discussions on JIF can be explored further by editors and researchers in considering where to publish.

The latest global impact factor for [21] according to Google Scholar is 2012 = 1.63 and 2011= 0.59.

The earlier foundational understanding of indices is applied in this article while focusing on collaboration. The value of an index is encapsulated and supported by the statements below:

- A coefficient or measurement of collaboration between collaborators
- An impact factor for the collaborator as inspired by South African Journal of Information Management (SAJIM) citation index.

C. Other indices

The [4] describes the ICT Development Index (IDI) as follows:

"*…combines 11 indicators into one benchmark measure for monitoring and comparing ICT developments across countries. Countries are ranked according to their level of ICT access, ICT use and ICT skills*" [4].

The value of an index is also discussed by [4]. This is part of the ICT Development index which is described as aiming to address:

- The changes from position to another is analysed and changes are proposed to enable improvement.

- There is also an interest in the number of individuals using the Internet.

V. METHODOLOGY

The methodology for this investigation started with the development of a questionnaire for data collection. The questionnaire was subsequently used to collect data from the websites of the selected research institutions and journals. The selection of the research institutions was based on purposive sampling.

Purposive sampling is described as the most important non-probability sampling method which allows researchers to rely on their experience and previous research findings [27]. Being a study that focuses on a qualitative approach coding was used for analysis.

A. The questionnaire

Appendix A was developed with questions used to collect data. These are questions asked by the research team when collecting data from the websites. It is important to note that the questions are formed to answer qualitative objectives and considers some quantitative aspects. A sample of the research institutions was selected in order to apply the questionnaires. Samples need to produce reliable evidence about a large population [19]. A valid sample must therefore represent the characteristics of the population.

B. Open acccess journals as a source

Data was also collected from open source journals. A complete list can be located from [16]. AOSIS OpenJournals is a commercial publisher of peer-reviewed scholarly journals which covers a wide range of academic disciplines. This provided a central location for finding links to multiple journals at once. A total of 25 OASIS journals can be found from the main website.

C. Other existing data sources

Additional data was extracted from an e-collaboration study conducted from 2009 - 2013. This study used observations, interviews, and questionnaires to collect data and later analysis was done through the coding method. The table below shows the categories of participants considered for the article from the main study.

TABLE III. PARTICIPANTS WHO RESPONDED

Category Name	Total
South Africa (SA) universities	18
SA Open Access Journals	5
Statutory Research Bodies (SRB)	7
Research-funding institution	1
Participants from a blog	75[a]
Total	**97**

a. This was the latest on 2013-11-10th

The significant level of interest can be noted from the table by bloggers which confirmed the fast evolution of electronic communication. The development of the index and the supporting data model was the epitome of the article. A discussion ensued to establish the use and value from the proposed findings.

VI. INDEX RATIONALE AND SUPPORTING THEORIES

The rationale for this index was motivated by multiple dimensions; these are discussed further in this section. The main theories that support the development of the index are also featured.

A. The index rationale

Firstly while examining existing indices a number of limitations were noted. These included indices not having a clear focus on the participation by researchers and their collaboration interests over a period of time.

Secondly through this article the importance of tracking researchers and keeping their profiles updated would be highlighted. This becomes necessary when researchers move from one institution to another. The scores allocated in this section aim to address this in the developed index.

The third rationale was to indicate that advances in index development should not have limits and can include other factors considered to be important about researchers that should be collected. These will enable and improve accessibility to researchers and demonstrate how active a researcher has been in academia. Recent work in the main study noted the challenges caused by the movement of researchers without updating their details with the main institution they work with or are affiliated to. The weights and scores assigned in the index were derived from this experience.

Fourth and finally the index developed features many factors as indicated in the basket while indices such as JIF only provides information about the citation frequency of an article. Having many elements in the index provides researchers with opportunities to improve their score and presents more prospects for future collaboration.

B. Supporting theory for index

Constructivism theory and diffusion of innovations (DOI) were the two theories considered for this investigation.

The constructivism theory reinforced the development of an index firstly by focusing on key elements in the definition. Further to this was how it has been used in other studies.

Constructivism is defined as follows [28]:

"*A paradigm or worldview posits that learning is an active, constructive process. The learner is an information constructor. People actively construct or create their own subjective representations of objective reality. New information is linked to prior knowledge, thus mental representations are subjective*".

In defining the constructivism theory, [29] indicates that knowledge is constructed from and also shaped by experience. The experience of working with researchers in the main study contributed towards the development of this index. The details on the experience are also highlighted in the earlier section on "*The index rationale*".

While using the theory of constructivism, [30] indicates that students are the main body of learning activity and they construct knowledge on their own initiatives.

Collaboration must take place in a social system towards accomplishing a shared goal [17]. For this reason DOI was considered in the development of this index. The index is noted as an innovative idea that will improve knowledge sharing by researchers and for research institutions.

VII. ARTICLE FINDINGS

This section begins by presenting the questionnaire results and the basket of collaboration index factors. The collaboration index example represents a data model to support the newly developed index. The final section discusses the use of the collaboration index overview.

A. The questionnaire results

The following table represents a summation of the results based on the questionnaire.

TABLE IV. SUMMATED RESULTS FROM QUESTIONNAIRE

#	Question	Yes / No	Additional comment(s)
1	Is there a publication with a journal impact factor (JIF)?	Variable	* All the journals had a JIF on their websites.
2	Can I locate / search for a researcher at the research institution?	Yes	-
3	Are the contact details available?	Yes	* Provide an email address on the website for future contact.
4	Are the contact details sufficient for a potential initiative? If answer is NO, provides the type of details that will be sufficient.	Yes	-
5	Can the research focus areas by the researchers and institution be clearly identified?	Yes	* Yes, these can be found if they are lecturers and research Professors. * This is also easier when there are specific projects that are running or recently completed initiatives.
6	Does the website provide research outcomes by the institutions and its researchers?	Yes	-
7	Is there an active online publication space on the website?	Yes	All the institutions have implemented a dataset for research results
8	Provide any other details related to the theme of collaboration on a website.	Yes	-

All the OASIS journals were found to have matrices. From the sites visited this is a standard feature for each one of the journal websites. This supports the importance of publication and being widely cited.

B. The basket of collaboration index factors

The factors that inform the collaboration index are also known as the basket. This section contains the entities, attributes and scoring ranges. Each entry is listed with their respective attributes and conditions for earning points.

Entities and attributes:

- **ENTITY: 1 - Researcher**

    This entity is based on the main participant in a collaboration activity or episode. Researchers are the key and starting point towards working together at research institutions.

    The identified attributes are: *Name; *Surname; *Institution Champion (yes or no); *Email address; *Blog; and *Date of registration in *eCollabIndex*.

- **ENTITY: 2 - Institution / organization**

    This entity represents the environment in which the collaboration initiative would take effect. Research institutions support collaboration and therefore become a good starting point. Other organizations can also participate.

    The identified attributes are: *Name; *Web address; *Institution champion details; and *Institution champion email.

- **ENTITY: 3 - Interests / Niche areas**

    Interest and niche areas are specific for each researcher and institution and it therefore becomes important to know them for potential collaboration. This entity is intended to collect and store the interests and niche areas of each collaborator. These are the themes and subjects for each one of the collaborators.

    The identified attributes are the details from each interest or subject area.

- **ENTITY: 4 - Collaboration Output / results**

    This entity is intended to collect and store the output and results of the initiatives conducted. This entity would also feature the latest work that has been completed. The identified attributes are the details from output.

- **ENTITY: 5 – Online publication of research output**

    This entity caters for online publications on websites. There are tools such as Research Space that are used on the research institutions' websites. This enables the research institutions to publish their output, such as edissertations, thesis, articles for journals, conference proceedings, posters and others.

Scoring ranges:

The table below shows the different scoring ranges. The concept of scoring minimum and maximum is developed to ensure that the index value can be translated within a range. The scoring is based on the importance of the details being captured on the index. Maintaining updated details is an important part of the index and has high additional score.

TABLE V. SCORING RANGES AND DETAILS

Entity (Table)	Attribute (Field)	Min	Max	Condition or reason
-1- Researcher	Name	1	4	4 if available and valid
	Surname	1	2	2 if available and valid
	Institution Champion	2	4	4 if available and valid
	Email address	2	4	4 if available and valid
	Blog	2	4	4 if available and valid
	Date of registration in *eCollabIndex*	-	-	Any system generated date is allowed.
	Latest Update/review	1	6	The attribute must be updated at least once in an academic year (January – December).
-2- Institution / organization	Name	1	2	2 if available and valid
	Web address	0	2	2 if available and valid
	Institution champion details	0	4	4 if available and valid
	Institution champion email	0	4	4 if available and valid
	Country	0	4	4 if available and valid
	Latest Update/review	1	6	The attribute must be updated at least once in an academic year (January – December).
-3- Interests / Niche areas	Entries	0	15	[Multiples of 3 per entry, max 5]
	Latest Update/review	1	6	The attribute must be updated at least once in an academic year (January – December).
-4- Collaboration Output / results	Entries	0	15	[Multiples of 3 per entry, max 5]
-5- Online publication of research output	Latest Update/review	1	6	The attribute must be updated at least once in an academic year (January – December).
	Entries	0	15	* Having such a platform on the website to display research results leads to 5 points being allocated. * A functional site with the multiple functions of searching earns 10 points. * An active site with updated data and articles can earn a maximum of 10 points.

C. An eCollabIndex example

The table bellows shows an *eCollabIndex* example containing data:

TABLE VI. COLLABORATION INDEX DATA MODEL WITH EXAMPLES

Entity (Table)	Attribute (Field)	Score	Condition or reason
-1- Researcher	Name	4	Joe
	Surname	2	Soap
	Institution Champion	4	Yes

	Email address	4	Jose.Soap@dmn.InstWeb.cntry
	Blog	4	blogABC
	Date of registration in *ECollabIndex*	-	2013-01-01
	Latest Update/review	6	2013-10-15
-2- Institution / organization	Name	2	University of ABC
	Web address	2	www.institutionwebsddress.country
	Institution champion details	4	Yes
	Institution champion email	4	Dude.Sample@dmn.InstWeb.cntry
	Country	4	South Africa
	Latest Update/review	6	2013-10-15
-3- Interests / Niche areas	Entries	15	[Multiples of 3 per entry, max 5] * Access to information * Technological theoretical foundations * New technology initiatives * Computer systems for business enhancements
	Latest Update/review	6	2013-10-15
-4- Collaboration Output / results	Entries	12	[Multiples of 3 per entry, max 5] * Published article AAA in journal * Supervised student AAA at institution XYZ for a degree in Computer Science * Collaborated funding with institution ABC from 2014-2016
-5- Online publication of research output	Latest Update/review	6	2013-10-15
	Entries	15	* A research space allowing access to a database of publications online has been implemented on the website * There is also a contact person for the database publishing

The table above is an example of the entries that can be captured. This can be transformed as it is being used.

D. The collaboration index overview and formula

The index was named "*eCollabIndex*" derived from "electronic", "collaboration" and "index". This first version is based on data collected from institution ABC (renamed to make it confidential), faculty XYZ at a few of the departments. An entry with the below index score can then be featured on website of the institution. This is best placed on the pages for the research and innovation or the post graduate section.

The formula for the *eCollabIndex* is as follows:

- [A] – Total number of researchers at an institution

- [B] – Total number of researchers registered on the *eCollabIndex*
- [C] – Average score per registered researcher (Add up all the individual scores and divide them by the results of [B]

The final computation of the *eCollabIndex* formula:

- $(A / B * 0.4) + (C * 0.6)$
- The weight of 40% is given to the ratio of the total researchers in relation to those that have registered on the index. While on the other hand the weight of 60% is given to the level of participation by the registered researchers.
- The index will always be a value less than 100%.

TABLE VII.   ECOLLABINDEX LEVELS

Level translated	*Value range %*
No index	0
Low	01 → 40
Medium	41 → 60
High	61 → 80
Very High	81 → 90
Exceptional	91→100

Below is a table showing the *eCollabIndex* scores from the data used. This table will also feature a translation of the indices for each one of the institutions' score

TABLE VIII.   COLLABORATION INDICES FROM DATA COLLECTED

Rank	*Participating institution name*	*Index score (1 – 100)*	*Level translated*
1	XYZ	90%	Very High
2	AAA	79%	High
3	BBB	41%	Medium
4	CCC	30%	Low
5	DDD	22%	Low
6	EEE	13%	Low

VIII. ARTICLE DISCUSSION

This section features the discussions on the article starting with the use and value followed by the extensibility of the developed index.

A. The use and value of the Collaboration Index

This section initiates a discussion on the use and value of the Collaboration Index. One of the main outcomes will be to have the index details displayed on the website of a research institution. The table below shows how the *eCollabIndex* can be displayed on a website or a publication.

TABLE IX. eCollabIndex for University of XYZ

Last updated on	Champion details	Index %	Level
2013-10-15	Mr. Joe Soap, Dude.Sample@dmn.InstWeb.cntry	90 %	Very High

The preceding sections showing examples demonstrate the practical usage of the index and provide a guide on possible future entries. A discussion focusing on value and use is featured below with each of the elements:

- **Overall benefit and value:** The output from all the entities can guide researchers, institutions, government and internationals on the current and future investigations. This can inform planning and strategy by any participant or user.
- **Researcher:** Researchers can be identifiable and easy to locate by prospective collaborators.
- **Institution / organization:** Organisations can collect data and use it for planning and strategic ideas for the future.
- **Recent activities / interests / niche areas:** These interests can guide both the individual researchers and institutions for future planning. Opportunities for sharing common challenges and solutions bases on the individual interests can be presented.
- **Collaboration Output / results:** Future collaboration can be motivated by seeing the results. Duplication can be avoided by researchers and institutions by contacting the champion representative.

Online publication of research output: The functions on websites make it easier to locate potential researchers to collaborate with. Notifications can be sent to the researchers who have subscribed to the site also limited to areas of interest.

B. The extensibility of index

This section discusses how the index can be extended for improved use in other environments. Some of these extensibility opportunities are listed below:

- The number of items in the basket can be increased;
- The weight of the elements in the index can be adjusted;
- The index can also feature weights for researchers who work for more than on institution;
- Research institutions can also submit their items in the basket; and
- The index results can be featured on other forms of output published by the institution such as conference proceedings and posters. This will increase visibility.

The above extensibility options can be considered following investigations or in an attempt to examine the impact on existing and other empirical data.

IX. CONCLUDING THOUGHTS AND THE WAY FORWARD

The literature examined supported the link between collaboration, indices and the use of matrices. This article presented development work on an *eCollabIndex* that can be used by research institutions for improved research collaboration. The overall conclusion is that there is a place for an index for e-collaboration to improve collaboration initiatives. This can lead to further knowledge development and opportunities for innovation.

Countries can also make contributions to the indices as indicated by developing publications [4].

Further work can consider other elements into the basket of elements. Other theories can be used as a lens for improving the index. With the implementation of the *eCollabIndex*, data can be collected to inform upgrades to the index. Other new technologies such as Twitter can be used to initiate collaboration projects. Non-academic institutions can also consider using this index for identifying institutions to work with on their business projects.

Finally this index is valuable for initiating further investigations by research institutions.

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REFERENCES

[1] About.com, 2013, What is a Stock Index?, , Retrieved September 12, 2013, from http://etf.about.com/od/etfbasics/a/What_is_a_Stock_Index.htm

[2] Academy of Science of South Africa (ASSAf). 2010. The PhD study, An Evidencebased Study on how to meet the Demands for High-level skills in an Emerging Economy. Academy of Science of South Africa, Pretoria, Retrieved October 09, 2010, from http://www.assaf.org.za/wp-content/uploads/2010/10/40696-Boldesign-PHD-smalloptimised.pdf.

[3] Center of Science and Industrial Research (CSIR), 2013, CSIR Researchspace, Retrieved July 11, 2013, from http://researchspace.csir.co.za/dspace/.

[4] e-Skills Institute (e-SI). The institute newsletter. Edition 19, October 2013, Retrieved November 10, 2013, from http://esi-sa.org/media-and-publications/pdfs/edition19_newsletter.pdf.

[5] Guzmán Duque, A. P. G., González-Ladrón-De-Guevara, F., Del Moral Pérez, M. E. & Gil Gómez, H., 2013, "Universities behaviour and opportunities on Twitter. International Journal of Computer and Information Technology (ISSN: 2279 – 0764), Volume 02– Issue 05, September, 2013.

[6] Investopedia. 2013. Index Investing: What Is An Index?, Retrieved September 12, 2013 from http://www.investopedia.com/university/indexes/index1.asp

[7] Hudson, A., 2011. Five Ways to Improve Work Group Collaboration in Virtual Meetings. Grouputer Pty Limited, Retrieved July 15, 2011, Retrieved from http://www.grouputer.com/papers/5_ways_to_improve_work_group_collaboration.pdf.

[8] JIFACTOR, 2013, Submit your Journal to get Journal Impact Factor (JIF), Retrieved September 11, 2013, from http://www.jifactor.com/about.aspx.

[9] Kock, N., & Nosek, J. 2005, Expanding the boundaries of e-collaboration, IEEE Transactions on Professional Communication, 48(1), 1–9. doi:10.1109/TPC.2004.843272.

[10] Lavhengwa, T.J. & Van Der Walt, J.S., 2011, Websites: A Platform For Researchers And Academic Institutions To E-Collaborate. 10th Annual Information & Knowledge Management Conference. 22-23 June 2011. South Africa.

[11] Lavhengwa, T.J. & Van Der Walt. 2012. Theoretical Foundations To Support E-Collaboration In Research Institutions. Proceedings Of The 14th Annual Conference On World Wide Web Applications.7-9 November 2012, Durban, South Africa. http://www.zaw3.co.za.

[12] Lavhengwa, T.J., Buitendag, A.A.K., & Van Der Walt, J.S. 2013. An e-collaboration activity system for research institutions. *Issues in Informing Science and Information Technology*. Volume 10, 2013.

[13] Marra, R.M., Peterson, K., & Britsch, B. 2008. Collaboration As A Means To Building Capacity: Results And Future Directions Of The National Girls Collaborative Project. Journal of Women and Minorities in Science and Engineering, vol. 14, pp. 119–140, 2008.

[14] Mattessich, P. & Monsey, 1992, Collaboration-what makes it work: A review of research literature on factors influencing successful collaboration, Retrieved September 14, 2011, from http://www.ode.state.or.us/teachlearn/certificates/diploma/collaboration-definitions.pdf.

[15] Naude, F., Rensleigh, C.& Du Toit, A.S.A. 2010,'Using the open Web as an information resource and scholarly Web search engines as retrieval tools for academic and research purposes', SA Journal of Information Management 12(1), Art. #416, 6 pages. DOI: 10.4102/sajim.v12i1.416

[16] OASIS Openjournals, 2013, Browse by Title, Retrieved October 01, 2013, from http://www.openjournals.net/index.php?option=com_wrapper&view=wrapper&Itemid=102.

[17] Rogers, E. M. 2003. *Diffusion of innovations*. 5th ed. New York: Free Press.

[18] Sciencegateway. 2013. Journal Impact Factors, Retrieved September 11, 2013, from: http://www.sciencegateway.org/rank/index.html.

[19] Silverman, D. 2005. 2nd ed. *Doing Qualitative Research: A Practical Handbook*. London: Sage, p 160.

[20] Sithole, P, M. 2008. A model to facilitate collaboration between institutions of higher education and psychiatric health care services to promote psychiatric clinical nursing education. Thesis. Johannesburg. University of Johannesburg.

[21] South African Journal of Information Management (SAJIM), 2013, Retrieved April 30, 2013, from http://www.sajim.co.za/index.php/SAJIM/pages/view/alerts.

[22] Thomson Reuters, 2013, What does it mean to be #2 in Impact? , Retrieved October 15, 2013, from: http://community.thomsonreuters.com/t5/Citation-Impact-Center/What-does-it-mean-to-be-2-in-Impact/ba-p/11386.

[23] Tshwane University of Technology (TUT). 2013. TUTDOR opens global doors to digital information, Retrieved October 30, 2013, from http://www.tut.ac.za/News/Pages/TUTDORopensglobaldoorstodigitalinformation.aspx.

[24] University of Johanessburg (UJ), 2013, UJDigispace at The University of Johannesburg, Retrieved October 30, 2013, from https://ujdigispace.uj.ac.za/.

[25] University of Johanessburg (UJ), 2013, UJDigispace: Research Webometrics Report – June 2013, Retrieved October 30, 2013, from http://www.uj.ac.za/EN/Newsroom/News/Documents/2013/UJDigispace%20-%20Research%20Webometrics%20Report%20-%20June%202013.pdf.

[26] Ward, D. 2011. Librarian-Faculty Collaboration: An Imperative for Higher Education, Retrieved May 12, 2013, from www.library.arizona.edu/.../Librarian-FacultyCollaboration-Powerpoint.ppt.

[27] Welman, J.C. & Kruger, S.J. Mitchell. 2010. Research Methodology Third Edition: Oxford University Press Southern Africa (Pty) Ltd.

[28] Learning-Theories, 2013, Constructivism, Retrieved December 04, 2013, from http://www.learning-theories.com/constructivism.html.

[29] Christie, A., 2013, Constructivism and its implications for educators, Retrieved December 04, 2013, from http://alicechristie.com/edtech/learning/constructivism/index.htm

[30] Jia, Q, 2010, A Brief Study on the Implication of Constructivism Teaching Theory on Classroom Teaching Reform in Basic Education, International Education Studies, Vol. 3, No. 2; May 2010.

APPENDIX A: QUESTIONNAIRE FOR DATA COLLECTION FROM WEBSITES

TABLE X.   QUESTIONNAIRE FOR DATA COLLECTION

#	*Question*	*Yes / No*	*Provide additional comment(s)*
1	Is there a publication with a journal impact factor (JIF)?		
2	Can I locate / search for a researcher at the research institution?		
3	Are the contact details available?		
4	Are the contact details sufficient for a potential initiative? If answer is NO, provides the type of details that will be sufficient.		

#	Question	Yes / No	Provide additional comment(s)
5	Can the research focus areas by the researchers and institution be clearly identified?		
6	Does the website provide research outcomes by the institutions and its researchers?		

#	Question	Yes / No	Provide additional comment(s)
7	Is there an active online publication space on the website?		
8	Provide any other details related to the theme of collaboration on a website.		