A proposal Statistical Model for Ranking LDCs Universities

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Abstract:

The so-called third goal of universities—community services, teaching quality, and scientific research seem to be the metrics used by the global ranking of universities to assess how well these institutions are performing via their websites. The third mission was divided into three categories, as this paper explains. The significance of measuring these categories and indicators is discussed in the paper. The study employed statistical software for data analysis, SmartPLS software for model validation, and questionnaires to gather information from subject matter experts. The categories of appropriate indicators and weights for each to be used in measuring research, teaching, social engagement, knowledge transfer, and innovation at universities are shown in the results. Finally, the study introduces university rankings model for Sudan and LDCs.

Keywords—global ranking; research; higher education; reputation; third mission

I. Introduction

Ranking universities is a challenging task because each institution has its own mission, vision, focus, and different academic programs. Furthermore, institutions differ in size and have varying amounts of resources; some have a long, aging history, while others are new. Taking into consideration that each country has its own structures, systems, and laws that govern higher education institutions, which themselves differ from other countries to another [1], The system of colleges and universities specifies how they compare to others; therefore, it is very difficult to rank universities, especially across national borders, according to the single criterion of ranking indicators.

There is an extended history of HEIs competing with one another for college students, teachers, donors, and social support. For a protracted time, the competition has been evaluated by its implicit reputation without any data to support such perceptions. However, with the heightened competition between universities since the 1990s, most popular university rankings, especially global rankings, rely heavily on measuring research and education quality [2].

The priority for most universities is to improve their global rankings in league tables. On the other hand, world university rankings serve as the first reference for students' choices for universities across the globe, provide public policy guidance, help decision-making, funding agencies, and university leaders, and play a vital role in positioning and measuring the performance of higher education institutions in global contexts [3], [4], [5], [6], [7].

University rankings are typically based on some combination of institutional performance indicators: teaching, research, service, which is the so-called third mission, and institutional characteristics: mission, size, regional locations, etc., and other factors. Institutional performance is the stated consideration of many ranking surveys, especially rankings that compare institutions across nations.

The majority of 'rankings' and all 'league tables attempt to reflect the quality of institutions and/or study programs in an ascendancy of the types and

domains for which the listing is being done. Here is a long history of colleges and universities competing with each other for students, teachers, donors, and social support.

The world-ranking universities measured research and quality of teaching and did not concern themselves with the services of universities, while most university laws and missions contain services. Therefore, universities in Sudan and Least Developed Countries (LDCs), which have limited financial resources, have less productivity in research and teaching and thus have a lower ranking in the world ranking system.

The global university rankings systems were not suitable for universities in Sudan and LDCs; thus, the study wanted to find the criteria and weights of indicators to measure universities in Sudan and LDCs. The European Indicators and Ranking Methodology for University Third Mission (E3M) project deals with the lack of generally agreed indicators or a coherent methodology for evaluating the activities of the third mission of universities.

a) Motivation

The global ranking systems were found to concentrate on measuring mainly research and teaching quality. Only a few gave very minor weight to some third-mission activities. Despite this, the study found that all universities across the world have engaged in responsibilities and activities geared towards their communities and represented this commitment through their mission and vision statements.

b) Paper Contribution

The main aim of this study is to propose and develop a new model for university ranking systems for Sudan and LDCs using suitable criteria and measurements. The objectives of this study are:

1. Study the global university rankings system's
2. To select appropriate indicators to measure university activities according to the criteria selected.
3. proposed new model and weighted for the indicators selected.

4. To validate the new model using SmartPLS software.

For all these reasons, international ranking systems did not represent LDC universities, which work closely with communities and governments to lift their nations from the LDC list. The rest of this paper is organized as follows: Section II: theoretical background; Section III: lustrate research methodology; Section V: explained results and discussion; Section VI: highlights and concludes the study.

II. Theoretical Background

For a long time, the competition has been evaluated by implicit reputation; however, with the heightened competition between universities and the dramatic growth of the international higher education market, surveys show that the relationship between the university and the community is greater, and services activities [8] done by universities toward communities need more criteria and weights when measuring university ranking.

The concept of measuring research quality is very complicated to accurately measure, often measured by the number of publications or citations by the members of the faculty or the amount of funding for external research projects. The number of publications represents the quantity of research productivity; citations can be used to determine the impact of research on others; some rankers use the number of articles published in international journals mentioned by the Institute of Scientific Information (ISI) or SCOPUS; some international journals may not be listed in ISI or SCOPUS [9], because the indexing prefers English [10].

Furthermore, HEIs should provide a path containing information relevant to the institution, such as the number of faculty, students, research centers, staff, events held, awards gained, facilities, equipment, and any relevant information that illustrates the institution's goals and capabilities[11] [12].

The international indexing services underestimate publications in non-English-speaking countries. External research funding is considered a better measure of research quality than quantity because it is a popular indicator of

productivity based on peer review, but funding may also lead to a larger amount of research, which is the component of quantity.

Sometimes teaching quality is measured by students college experience; generally, most ranking relies more on measuring research productivity than teaching quality. This aspect of higher education remained untapped in the university rankings because there is difficulty in determining and measuring the third mission, although service is one of the basic functions of universities along with scientific research and teaching[13].

The International Ranking Experts Group (IREG) Observatory of Academic Ranking and Excellence is an international, not-for-profit institutional association of entities interested in university rankings and academic excellence such as institutions of higher education, research, and some other organizations. IREG was founded in 2004 by the UNESCO European Center for Higher Education in Bucharest and the Institute for Higher Education Policy in Washington [14], DC. The meeting of these bodies was held in Berlin in May 2006 to consider the establishment of principles of quality and good practice in the classifications of higher education institutions - the so-called Berlin Principles on the Classification of Higher Education Institutions.

Its purpose is to raise awareness of university rankings and to understand a range of issues related to university ranking and academic excellence. It has been called the International Ranking Experts Group (IREG). In 2009 this unofficial group was transferred to the IREG Observatory as a non-profit organization. It was registered in Brussels, Belgium, and the group presidency is located in Warsaw, Poland Berlin Principles on Ranking of Higher Education Information

This initiative established a framework for the development and dissemination of national, regional, and global rankings in scope and will eventually lead to a system of continuous improvement and refinement of the methodologies used to conduct these rankings. These classifications and methodologies are not homogeneous, so these principles will be useful for

continuous improvement and evaluation [14]. Third mission activities are one of the major topics for higher education institutions, so many universities are seeking to gather information on their third mission activities in order to ensure their effective management.

E3M is a project co-financed by the European Commission under the Lifelong Learning Programme, coordinated by the Universidade Politécnica de Valencia, and developed by eight partners from seven different European countries [23], [24], [7]. This project aims to create a standard methodology for classifying and measuring the activities of the third mission of universities, which adds to the other two missions of universities in education and scientific research and represents a new approach that reflects all the contributions of universities to society [25].

According to Marhl & Pausits [14], the third mission is classified into 12 activities, and the 54 indicators for the third mission activities have developed as follows: a) Continuing Education (CE) refers to lifelong learning activities; b) Technology Transfer and Innovation (TTI); c) Social Engagement (SE). The E3M project also proposed three directions for structuring third-mission activities indicative of the third mission of universities [25].

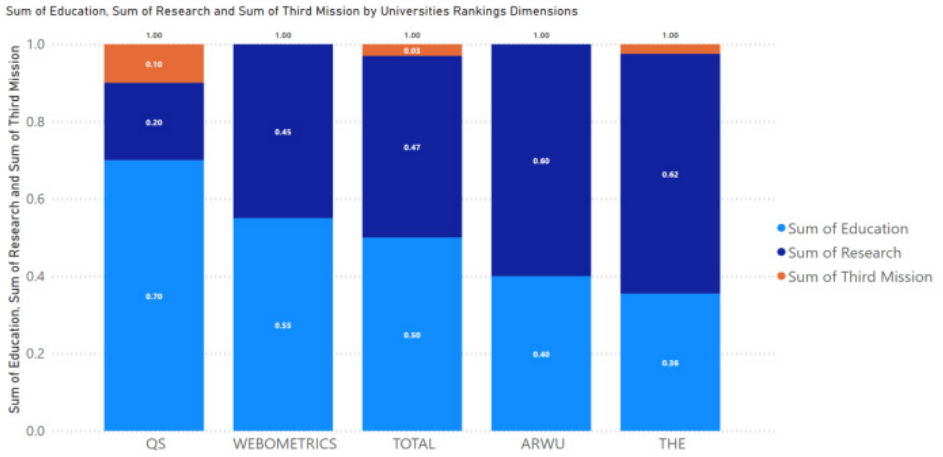

Figure 1. Summary of World Universities Rankings Dimensions

Figure 1 explains that the third mission has a 3.125 percent over all four

rankings, while research has a 50.125% and education has a 46.75%, while the dimensions of the third mission activities are the main features and the most prominent entities of the university activities [19], which the universities carry out in order to fulfill the third mission. The analysis has shown that it is reasonable to introduce three basic dimensions of the university's third mission activities: CE, TTI, and SE.

III. Research Methodology

This section presents the results of the exploratory study, including the proposed, the survey, data collection, and data analysis and validation. This study analyzes the methodology used in the well-known university ranking systems in the words Quacquarelli Symonds (QS) [24], Academic Ranking of World Universities (ARWU) [22], [23], Webometrics [24], [25], [26], [27], beside Times Higher Education (THE) [28], [29], [30], and analyzes the literature review of previous studies, creates a preliminary model, uses Google tools to design a questionnaire, validates it before collecting data from experts in the fields, and then analyzes the results and designs the proposed model using software tools. Figure 2 shows the flow of the study. Figure 3 shows the preliminary rankings Model

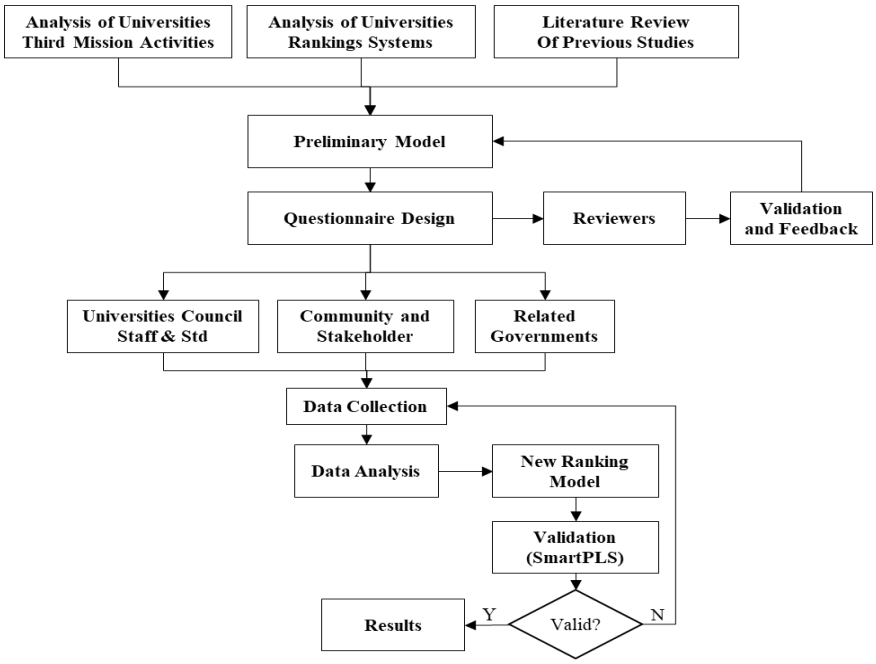

Figure 2. The Flow of the Study

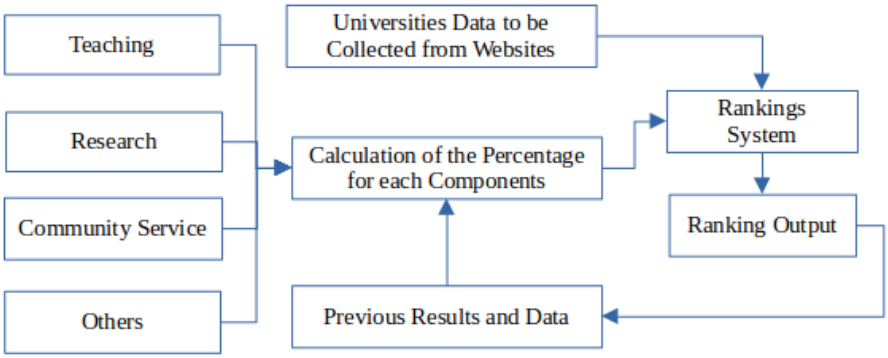

Figure 3. Preliminary rankings Model

A. Survey Development

In this study, the implemented survey questionnaire consists of Three parts, as explained in the following paragraphs:

1. The first paragraphs include general personal information about the field experts, which include teaching staff, managerial staff, university employees, and students.
2. The second part contains the general opening questions about the famous university ranking systems in the world.
3. The third fragment includes four questions, as follows:

a) Expert opinions on the world university ranking systems: were they suitable for LDC universities?

b) The impact of research reputation and income on university rankings

c) The impact of reputation and quality of teaching on the university rankings

d) The impact of universities third mission on the university rankings includes continuing education, social engagement, technology transfer, and innovations.

For the constructs reflected in the questionnaire, the measurement followed the Likert-type 5-point scale [27], as follows: Strongly disagree = 5. Disagree = 4. Undecided = 3. Agree = 2. Strongly agree =1.

B. Validity and Readability

In this research, Google Forms (a web-based tool) is applied and used in the survey questionnaire [31]. More importantly, to ensure the validity and reliability of the survey questionnaire, we have employed the survey questionnaire that was shared with experts to test its validity [31]. Validation of questionnaires by experts is dependably engaged in the research field [21]. So the draft of the survey questionnaire was sent to three experts, professors at universities in Sudan.

C. The Data Collection and Analyses

The questionnaire was distributed online via the internet, including whatsapp messages to selected professors, Facebook Sudanese research groups, and university information center groups. The questionnaire covered different geographical areas of Sudan, including all universities in Sudan in Khartoum capitals and states. The universities were distributed in all states, including private and special, beside the Sudanese scholars at universities in Saudi Arabia, Qatar, Egypt, and others. As the results indicate, 273 respondents were received, and studies suggest that 100–150 is sufficient [32], [33], hence the sample size of 274.

D) Data Analysis

For the analysis of this study, the following considerations were taken:

1. Treatment of missing values: the research realized that some questions lifted blank and were not answered, but the rate of non-answered questions was not high and not specifically focused on specific items. So, the researchers decided not to make any corrections. Some answerers to questions particularly focused on the evaluation of the suitability of the global university ranking system.
2. Some answered questions, particularly those focused on the indicators or criteria to measure universities' activities.
3. The analysis considered the answers that have a rate of.300 and above and dismissed the rate below that.
4. The selection of indicators was organized into five groups.

5. The questionnaire covered all states in Sudan.

IV. RESULTS AND DISCUSSION

The results and discussion section presents and analyzes the obtained results, including the results of the measurement model and the results of the structure model.

A)Demographic characteristics of participants

As shown in Figure 4, of the 274 respondents, 240 (87.6%) were Sudanese, as presented in Figure 1. 70 (25%) are female and 183 (66.8%) are male; furthermore, 79 (28.8%) are assistant professors, while 74 (27%) are from the technological fields. 105 (38.3%) respondents were from Khartoum, the capital of Sudan.

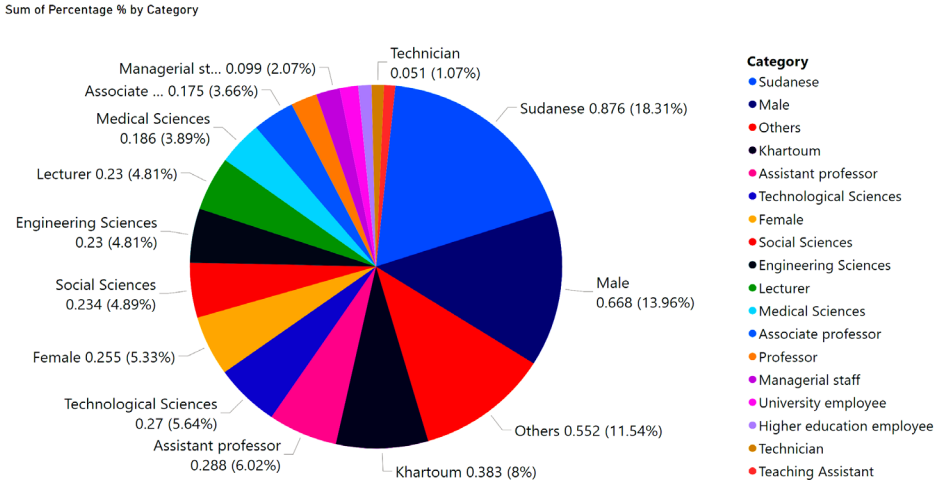

Figure 4. Demographic Statistics of Participants

From the literature, this study found that the global university rankings focus on measuring research and teaching as they are classified to measure the performance [34] and reputation of universities and give small proportions to the third mission, while the nations of LDCs [35] wants the universities to graduate from the List of LDCs and that they need more contributions from universities toward their communities. For this reason, all LDC universities need fair criteria to measure their universities.

C) The Proposed Model

To design a ranking model, the study used Unified Modeling Language, which is a standard visual modeling language intended to be used by business analysts, software architects, and developers to describe, specify, design, and document existing or new business processes, the structure, and the behavior of artifacts in software systems. The study uses use-case diagrams, which are usually referred to as behavior diagrams, to describe a set of actions that some system or systems should or can perform in collaboration with one or more external users of the system. Each use case should provide some observable and valuable result to the actors or other stakeholders in the system [36]. Figure 5. shows the use-case diagram for the model, the acronym apear in the diagram is a linguistic term to avoid the long term in the diagram.

After carefully analyzing the data, the following categories and indicators and the weight for each selected indicator were found to be suitable for Sudan and LDCs according to the experts opinions. The indicators were described according to the groups to which they belong, and the results of the analysis show the division into four groups, namely research, social engagement, teaching, knowledge transfer, and innovation. Then, the study was carried out on group indicators according to their similarity.

The following list indicators were selected for teaching: 6 indicators with 29 total weights: academic staff-to-student ratio 6.5, the proportion of international students 6, the proportion of international staff 5.5 Education tools, curriculum review and developments, and electronic libraries 5.5, reputation survey teaching 3.0, and income per academic year 2.0.

The following indicators were selected for research: 6 indicators with 16 total weights: teaching staff with Nobel Prizes and Fields Medals 2.0, papers published in Nature and Science 3.0 reputation survey Research 3.0, top cited papers and researchers amongst the 10% most cited 3.0, research collaboration 3.0, general reputation among scholars 2.0

The following indicators were selected for social engagement: 14

indicators with 27 total weights: academic weights: academics involved in volunteering and advisory activities to the community 2.0, events open to the community and the public 2.0: Research initiatives with a direct impact on the community 2.0, the existence of a strategic plan and budget for continuing education to achieve community development 2.0. Educational outreach projects related to the community 1.0, community participants in an educational outreach activity 1.0, university activities specifically targeting disadvantaged students and the community 1.0.

Community representatives on the university boards or committees 2.0, participation in professional and national or state committees from university members; 2.0, workshops and seminars by university members for the community 2.0, designing training courses aligned with community services for teaching and non-teaching staff; 2.0, CE programs presented by the university per year; 3.0, partnerships with public and private businesses in CE programs delivered per year 2.0, registered trainees in CE programs per year 3.0The following indicators were selected for knowledge transfer and innovation: 8 indicators with 28 total weights: research and development-sponsored agreements, contracts, and collaborative projects with non-academic partners 4.0, research income from industry per academic staff 3.0, consultancy contracts by university members with the community, government, or industries 3.0, postgraduate thesis or projects with non-academic co-supervisors 4.0, budget coming from the income of R&D-sponsored contracts and collaborative projects with non-academic partners 4.0, postgraduate students and postdoctoral researchers are directly Funded or co-funded by public and private businesses 4.0, academic staff from the university participating in professional bodies, networks, organizations, and boards 4.0, start-ups and spin-offs established 3.0.

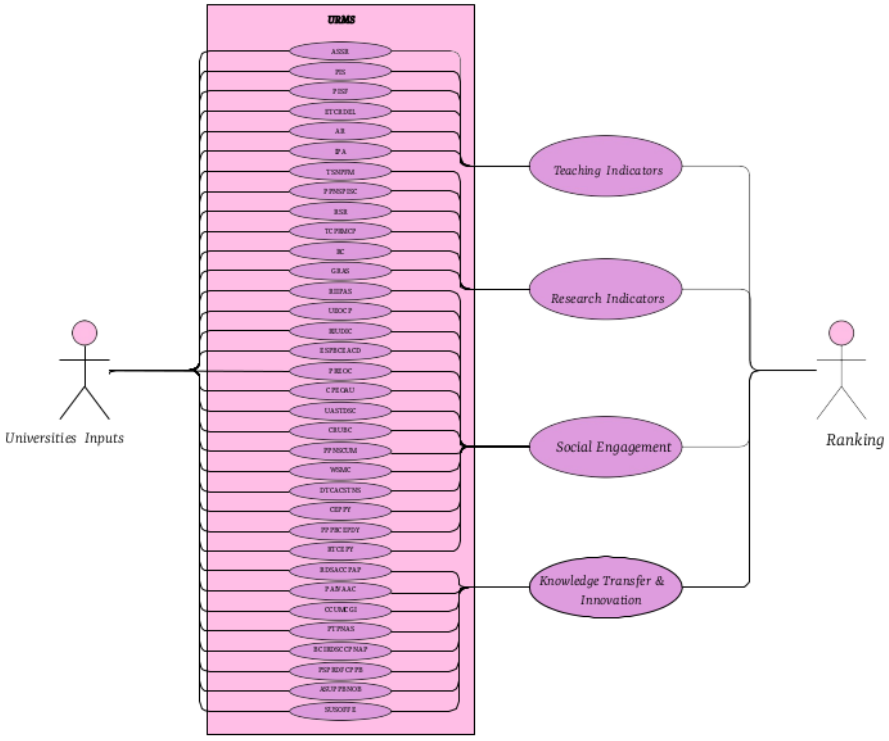

Figure 5. The Proposed Model

D) Validation of the Proposed Model

The row data from the questionnaire were analyzed using SPSS software tools. In this research, factor analysis and principal component in a structure are two statistical procedures that draw on item correlation to find a small number of factors, significantly reducing the analysis's complexity [37].

E) SmartPLS Software

SmartPLS GmbH was founded as a private company in 2015 and specializes in solutions that help scientists get the most out of their own data. Its core product is SmartPLS, a world-renowned software for data analysis using the PLS-SEM method. is a software with graphical user interface for variance-based structural equation modeling (SEM) using the partial least squares (PLS) path modeling method.

Principal component analysis (PCA) and factor analysis are used to identify the structure of a set of variables. Using PCA, or factor analysis, helps find interrelationships between variables (usually called items) to find a smaller number of unifying variables.

PCA and factor analysis both explain patterns of correlations within a set of observed variables. That is, they identify sets of highly correlated variables and infer an underlying factor structure [38]. Factor analysis formula

$$X = \mu + E + e \qquad (1)$$

where X is the p x 1 vector of measurements, μ is the p x 1 vector of means, L is a p × m matrix of loadings, F is a m × 1 vector of common factors, and e is a p × 1 vector of residuals.

Moreover, SmartPLS software tools [39] are used to analyze the data. The data was transferred through an intermediary (Microsoft Excel) to allow SmartPLS to read the data. Figure 6. shows the diagram of measurement model by SmartPLS as follows:

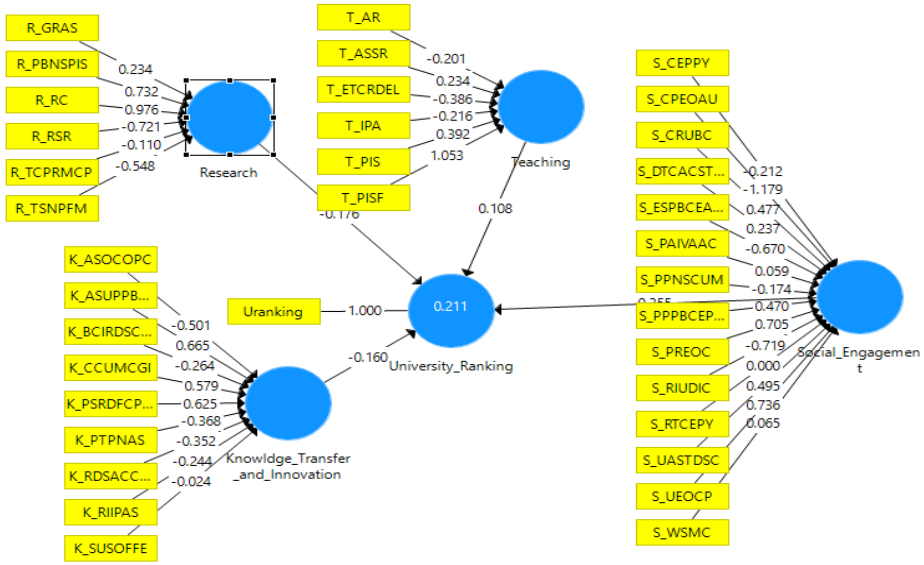

Figure 6. Validation of the Measurements Model

In a measurement model that includes relations amongst the latent variables and their items (indicators), the study gives a non-significant name for each indicator just for the purpose of the model; in the recommended model section, the indicators are written in real names [42]. In this study, the following are measured:

A) ***Internal Consistency Reliability*** which is measured by Cronbach's alpha, provides an estimate of reliability based on the inter-correlation of the observed indicator variables, which are defined as follows:

$$\text{Cronbach}'\text{sá} = \left(\frac{M}{(M-1)}\right)\left(1-\frac{\sum_{1=1}^{M} s_i^2}{s_i^2}\right) \qquad (2)$$

above formula represent that s_i^2 represents the variance of the indicator variable (i) of a specific construct, which is measured by M indicators (i = 1, …, M), and is the variance of the sum of all M indicators of that construct Cronbach's criterion that all indicators have equal outer loading on the construct Due to Cronbach's alpha's limitations, reliability is technically more appropriate to apply a different measure of internal consistency [43].

B. ***Composite Reliability (CR):*** This measure of reliability considers the different outer loadings of the indicator variables and is calculated using the following formula:

$$\tilde{\text{n}} = \frac{\left(\sum_{i=1}^{M} li\right)^2}{\left(\left(\sum_{i=1}^{M} 1\right)2 + \sum_{i=1}^{M} \text{var}(\dot{\text{e}})\right)} \qquad (3)$$

where li symbolizes the standardized outer loading of the indicator variable I of a specific construct measured with M indicators, ei is the measurement error of indicator variable I, and var ei denotes the variance

of the measurement error, which is defined as 1− 112..., The composite reliability varies between 0 and 1, with higher values indicating higher levels of reliability. The accepted value can be between 0.70 and 0.90.

Also, the internal consistency measured by rho_A (Dillon Goldstein's rho or Jöreskog's) as rho is based on the values of the loading [44]. Accordingly, Jöreskog's (rho rho_A) is calculated for each of the model factors; acceptable scores for Jöreskog's rho are higher than 0.70 [44], and the rho_A was 1, so it will support the reliability of the measurement model.

C) Discriminant validity refers to the extent to which the constructs are empirically different from one another. It also measures the differences between the overlapping constructs. The discriminant validity can be evaluated by using cross-loading of indicators, the Fornell & Larcker criterion [45], and the heterotrait-monotrait (HTMT) ratio of correlation.

According to the traditional discriminant validity assessment methods, it compares the square root of the AVE values with the latent variable correlations. Specifically, the square root of each construct's AVE should be greater than its highest correlation with any other construct [46]. In Table 1, the bold number is the construct's square root for each; notice that it is higher than any other construct, thus supporting the discriminant validity in the measurement model.

Table 1: Discriminant Validity (DV)

	KT&Innovation	Research	SE	Teaching	Univ_ Ranking
KT&Innovation	0.178				
Research	0.035	0.272			
Social Engagment	-0.09	0.074	0.396		
Teaching	-0.048	-0.007	0.157	0.416	
Univ_Ranking	-0.203	-156	0.374	0.173	1

D) ***Indicator validity*** [47] and [29] include the variance inflation factor (VIF), which indicates how much of the indicator's variance is explained by the other constructs. The acceptable values of VIF are below ten [46]. In this

research, SmartPLS software was used to validate the reliability and validity of the measurement model. Figure 7. shows the indicator validity for each factor, all of them below 10, as the rule thump said that the value accepted if the construct is below 10 [48]. The formula for VIF is:

$$VIF = \frac{1}{\left(1 - R_i^2\right)} \qquad (4)$$

Where VIFs are usually calculated by the software as part of regression analysis, VIF was calculated by taking a predictor and regressing it against every other predictor in the model. This is given by the R-squared values, which can be plugged into the VIF formula. "i" is the predictor you're looking at (x1 or x2) [48].

V. Conclusion

The study found that Sudanese universities, as a sample of LDC universities, found that all of these institutions work extensively on a third mission, and to the contrary, they appear in only Webometrics ranking tables situated at the rear of the league table. Furthermore, most LDC universities appear in Webometrics at the rear of the league table.

Universities in LDCs have a mission to raise the assistance of their people in development and to graduate countries from the list because these world ranking systems aren't useful and appropriate for those countries. A new model was proposed that includes all the indicators that measure universities in their three missions. A model was designed and validated through a questionnaire using Google document tools and distributed online. Many 274 experts in higher education responded. The questionnaire was analyzed, and the results were a group of indicators with their weights and then packed into four pillars (categories), as follows: research 6, teaching 6, social engagement 14, knowledge transfer, and innovation 8. Each indicator has a weight.

To validate the model, SmartPLS software was used to verify the validity and reliability, using composite reliability and discriminant validity, which

give valid results. After that, the given indicators were entered in UML using a use-case diagram to design the new model, and Visual Paradigm tool used in drowning the model. The model we considered a novel one for measuring the ranking of Sudanese universities, LDCs. The research names this ranking university model for Sudan and LDCs (RUMS).

References:

(1) K. Frenken, G. J. Heimeriks, and J. Hoekman, "What drives university research performance? An analysis using the CWTS Leiden Ranking data," Journal of informetrics, vol. 11, no. 3, pp. 859–872, 2017

(2) P. Altbach, "The Dilemmas of Ranking in: International Higher Education," Journal of Studies in International Education, vol. 3, no. 6, pp. 121–133, 2007.

(3) M. N. Bastedo and N. A. Bowman, "College rankings as an interorganizational dependency: Establishing the foundation for strategic and institutional accounts," Research in higher education, vol. 52, no. 1, pp. 3–23, 2011.

(4) Ellen. Hazelkorn, "Rankings and the Battle for World-Class Excellence: Institutional Strategies and Policy Choices.," 2009, doi: 10.21427/D76P7M.

(5) T. Erkkilä and O. Piironen, "Rankings and global knowledge governance," Research Handbook on University Rankings: Theory, Methodology, Influence and Impact, p. 54, 2021.

(6) E. Hazelkorn, "Reflections on a Decade of Global Rankings: What we've learned and outstanding issues," European Journal of Education, vol. 49, Dec. 2013, doi: 10.1111/ejed.12059.

(7) A. Carrión, V. R. García-Gutiérrez, M. C. Bas, and J. M. Carot, "A new methodology for measuring third mission activities of universities," in INTED2012 proceedings, IATED, 2012, pp. 1218–1223.

(8) R. Vieira and M. Lima, "Academic Ranking—From Its Genesis to Its International Expansion," Higher Education Studies, vol. 5, no. 1, Art. no. 1, Jan. 2015, doi: 10.5539/hes.v5n1p63.

(9) B. V. Elsevier, About Scopus–Abstract and citation database. Elsevier Oxford, 2021.

(10) M. Marhl and A. Pausits, "Third mission indicators for new ranking methodologies,"Evaluation in Higher Education, vol. 5, no. 1, pp. 43–64, 2011

(11) Battah, K. Salah, R. Jayaraman, I. Yaqoob and A. Khalil, "Using Blockchain for Enabling Transparent, Traceable, and Trusted University Ranking Systems," in IEEE Access, vol. 11, pp. 23792-23807, 2023, doi: 10.1109/ACCESS.2023.3253948.

(12) M. M. Al-kassab, H. Al-Masalha, L. M. Abu hammad, A. m. Daradkeh and H. Al-khawaja, "Utilization of Information and Communication Technology (ICT) by Faculty Members at Information and Communication Technology College Al-Zaytoonah University in Jordan," 2023 International Conference on Information Technology (ICIT), Amman, Jordan, 2023, pp. 806-810, doi: 10.1109/ICIT58056.2023.10225928

(13) S. Al-Hagree et al., "Universities the Best Performers: A Cluster Analysis of Yemeni Universities Rankings," 2023 3rd International Conference

on Emerging Smart Technologies and Applications (eSmarTA), Taiz, Yemen, 2023, pp. 1-9, doi: 10.1109/eSmarTA59349.2023.10293385.

(14) C. Belenkuyu and E. Karadag, "Defining standards for rankings: An investigation of global university rankings according to the Berlin Principles," Eur. J. Educ., vol. 58, no. 3, pp. 510–531, 2023.

(15) R. Pinheiro, P. V. Langa, and A. Pausits, "One and two equals three? The third mission of higher education institutions," European journal of higher education, vol. 5, no. 3, pp. 233–249, 2015.

(16) B. Blasi, S. Romagnosi, A. Ancaiani, M. Malgarini, and S. Momigliano, "A new method for evaluating universities' third mission activities in Italy: Case study contribution to the OECD TIP Knowledge Transfer and Policies project," p. 14.

(17) M. Esmaeili, Assessment of users' information security behavior in smartphone networks. Eastern Michigan University, 2014.

(18) A. Pausits, "The knowledge society and diversification of higher education: From the social contract to the mission of universities," The European higher education area: Between critical reflections and future policies, pp. 267–284, 2015.

(19) A. Tabassum, M. Hasan, S. Ahmed, R. Tasmin, D. Md. Abdullah, and T. Musharrat, "University ranking prediction system by analyzing influential global performance indicators," in 2017 9th International Conference on Knowledge and Smart Technology (KST), Feb. 2017, pp. 126–131. doi: 10.1109/KST.2017.7886119.

(20) L. Laura, "QS World University Rankings methodology: Using rankings to start your university search," Retrieved June, vol. 12, p. 2022, 2022.

(21) O. Loyola-González, M. A. Medina-Pérez, R. A. C. Valdez and K. -K. R. Choo, "A Contrast Pattern-Based Scientometric Study of the QS World University Ranking," in IEEE Access, vol. 8, pp. 206088-206104, 2020, doi: 10.1109/ACCESS.2020.3037665.

(22) A.-P. Pavel, "Global university rankings-a comparative analysis," Procedia economics and finance, vol. 26, pp. 54–63, 2015.

(23) K. Soh, "What the Overall doesn't tell about world university rankings: examples from ARWU, QSWUR, and THEWUR in 2013," Journal of Higher Education Policy and Management, vol. 37, no. 3, pp. 295–307, May 2015, doi: 10.1080/1360080X.2015.1035523.

(24) M. Thelwall, L. Vaughan, and L. Björneborn, "Webometrics," Annual review of information science and technology, vol. 39, no. 1, pp. 81–135, 2005.

(25) S. S. Das, P. Balasubramanian, and A. R. Chowdhury, "Webometrics Ranking (WR) of World Universities and National Institutional Ranking Framework (NIRF): A Comparative Study," SRELS Journal of Information Management, vol. 56, no. 3, pp. 154–158, Jun. 2019, doi: 10.17821/srels/2019/v56i3/144386.

(26) I. Yakymenko, V. Kazymyr, and S. Lytvyn, "Webometrics ranking

analysis and possible ways to improve the position of the university," in 2020 IEEE 11th International Conference on Dependable Systems, Services and Technologies (DESSERT), May 2020, pp. 422–426. doi: 10.1109/DESSERT50317.2020.9124999.

(27) Y. Y. Prasetyawan, "Repositori Institusi Universitas Diponegoro: Sebuah Analisis Webometrics," Anuva: Jurnal Kajian Budaya, Perpustakaan, dan Informasi, vol. 1, no. 1, pp. 41–48, 2017, Accessed: Nov. 08, 2023. [Online]. Available: https://ejournal2.undip.ac.id/index.php/anuva/article/view/1903

(28) "World University Rankings 2022: methodology," Times Higher Education (THE). Accessed: Sep. 05, 2022. [Online]. Available: https://www.timeshighereducation.com/w%C3%B4rld-university-rankings/world-university-rankings-2022-methodology

(29) J. Salmi and A. Saroyan, "League tables as policy instruments: Uses and misuses," Higher education management and policy, vol. 19, no. 2, pp. 1–38, 2007.

(30) "M. Mussard and A. P. James, "Engineering the Global University Rankings: Gold Standards, Limitations and Implications," in IEEE Access, vol. 6, pp. 6765-6776, 2018, doi: 10.1109/ACCESS.2017.2789326.

(31) B. Petrić and B. Czárl, "Validating a writing strategy questionnaire," System, vol. 31, no. 2, pp. 187–215,2003,Accessed:Nov.08,2023.

(32) H. M. Alnajrani and A. A. Norman, "The Effects of Applying Privacy by Design to Preserve Privacy and Personal Data Protection in Mobile Cloud Computing: An Exploratory Study," Symmetry, vol. 12, no. 12, Art. no. 12, Dec. 2020, doi: 10.3390/sym12122039.

(33) L. Leydesdorff, L. Bornmann, and J. Mingers, "Statistical significance and effect sizes of differences among research universities at the level of nations and worldwide based on the leiden rankings," Journal of the Association for Information Science and Technology, vol. 70, no. 5, pp. 509–525, 2019.

(34) [Z. Chinchilla-Rodríguez, G. Zacca-González, B. Vargas-Quesada, and F. de Moya-Anegón, "Benchmarking scientific performance by decomposing leadership of Cuban and Latin American institutions in Public Health," Scientometrics, vol. 106, no. 3, pp. 1239–1264, Mar. 2016, doi: 10.1007/s11192-015-1831-z.

(35) C. S. Bernardo, G. J. Endalew, T. Namgyel, and B. Y. Gebreyes, "Least Developed Countries (LDCs)," in Negotiating Climate Change Adaptation: The Common Position of the Group of 77 and China, Springer, 2020, pp. 61–71.

(36) D. Kulak and E. Guiney, Use cases: requirements in context. Addison-Wesley, 2012.

(37) J. F. Hair, R. E. Anderson, R. L. Tatham, and W. C. Black, Multivariate data analysis (4th ed.): with readings. USA: Prentice-Hall, Inc., 1995.

(38) E. Mooi, M. Sarstedt, and I. Mooi-Reci, "Principal Component and Factor Analysis," in Market Research: The Process, Data, and

Methods Using Stata, E. Mooi, M. Sarstedt, and I. Mooi-Reci, Eds., in Springer Texts in Business and Economics. , Singapore: Springer, 2018, pp. 265–311. doi: 10.1007/978-981-10-5218-7_8.

(39) T. Bøe, "The interaction effect of perceived competence and goal harmony on perceived usefulness," Creative Education, vol. 7, no. 08, p. 1136, 2016.

(40) J. F. Hair Jr, G. T. M. Hult, C. M. Ringle, M. Sarstedt, N. P. Danks, and S. Ray, Partial least squares structural equation modeling (PLS-SEM) using R: A workbook. Springer Nature, 2021.

(41) V. Safón, "What do global university rankings really measure? The search for the X factor and the X entity," Scientometrics, vol. 97, no. 2, pp. 223–244, Nov. 2013, doi: 10.1007/s11192-013-0986-8.

(42) J. Henseler, C. M. Ringle, and M. Sarstedt, "A new criterion for assessing discriminant validity in variance-based structural equation modeling," Journal of the academy of marketing science, vol. 43, pp. 115–135, 2015.

(43) "V. L. Crittenden and S. B. Walchli, "Book and software reviews," Journal of the Academy of Marketing Science, vol. 24, no. 3, pp. 273–275, 1996.

(44) T. Raykov, "Estimation of composite reliability for congeneric measures," Applied Psychological Measurement, vol. 21, no. 2, pp. 173–184, 1997.

(45) G. Demo, E. R. Neiva, I. Nunes, and K. Rozzett, "Human resources management policies and practices scale (HRMPPS): Exploratory and confirmatory factor analysis," BAR-Brazilian Administration Review, vol. 9, pp. 395–420, 2012.

(46) A. Leguina, A primer on partial least squares structural equation modeling (PLS-SEM). Taylor & Francis, 2015.

(47) W. W. Chin, "Structural equation modeling in IS research," in ISWorld Net Virtual Meeting Center at Temple University,[On-Line]. Available at http://www. interact. cis. temple. edu/~ vmc, 1998.

(48) S.-Y. Park and S. W. Lee, "Effects of a perceived brand crisis on product evaluation and purchase intention: the moderating roles of brand credibility and brand attachment," Journal of Global Scholars of Marketing Science, vol. 23, no. 2, pp. 213–226, Mar. 2013, doi: 10.1080/21639159.2013.763488.