IEEE Access
Multidisciplinary | Rapid Review | Open Access Journal

Received October 25, 2017, accepted December 18, 2017, date of publication January 5, 2018, date of current version March 9, 2018.

Digital Object Identifier 10.1109/ACCESS.2017.2789326

Engineering the Global University Rankings: Gold Standards, Limitations and Implications

MAXIME MUSSARD[1] AND ALEX PAPPACHEN JAMES[2], (Senior Member, IEEE)
[1]Department of Mechanical Engineering, Nazarbayev University, Astana 010000, Kazakhstan
[2]Department of Electrical and Electronics Engineering, Nazarbayev University, Astana 010000, Kazakhstan

Corresponding author: Alex Pappachen James (apj@ieee.org)

ABSTRACT Global University ranking tables influence students and public opinion perceptions and the overall reputations of universities among an international audience. In this paper, the credibility of such ranking tables is questioned based on the tendency of ranking systems to promote questionable universities, documented instances of ethical misconduct, and inconsistencies between different ranking tables. The findings are validated using the Academic Ranking of World Universities (or Shanghai ranking), the QS University ranking, and the THE World University ranking, which are considered the golden standards today among Global University ranking tables. Inconsistencies between ranking tables with respect to parameters used in analysis and validation are pointed out. Furthermore, it is shown that all three ranking tables can be gamed by universities to get a high ranking using parameters that do not capture the wide spectrum of characteristics that reflect academic excellence in research, teaching, and services.

INDEX TERMS Academic ethics, ARWU, QS University ranking, THE World University ranking, Shanghai ranking, ranking metrics.

NOMENCLATURE

ARWU	Academic ranking of World universities, best known as Shanghai ranking (since 2003).
QS	Quacquarelli Symonds (since 2010).
THE	Times Higher Education (since 2010).
THES	Times Higher Education supplement ranking (2004-09).
NP	Nobel prize.
FM	Fields medal.
FWCI	Field-weighted citation impact.
SNIP	Source normalized impact per paper.

I. INTRODUCTION

More than a decade ago, education specialists claimed that University rankings are here to stay [1]. Nowadays, facts show that they were right. Their impact on universities and national policies is now substantial [2]. Increased emphasis on university ranking tables is politically influential, often governed by the interests of both business and social actors who seek to highlight the prestige of educational institutions in order to attract students, funding and resources [3]. A top-ranked university can be the driver of economic and scientific growth within a region, as universities propel governments to develop policies that favor the growth of local industry and capacity. However, there is growing criticism of university ranking methodologies and the way they are presented or conceptualised.

Nevertheless, university rankings now have a major influence. Sidorenko and Gorbatova [4] explain how Russian universities can improve their ranking and thereby achieve the objective of the ministry of being in the top 100 universities in rankings (especially the QS ranking). In 2011, Saisana *et al.* [5] raised the issue of the reliability of the rankings and their influence in politics, noting that several decision makers are influenced by them. They demonstrate that the ARWU and THES rankings are resilient when taken on a regional basis but that a single university can experience large variations through minor modifications of one parameter (typically its weighting). The authors do not recommend the use of these rankings to compare university performance. The rankings also influence the choices of students regarding their candidatures, as demonstrated by Horstschräer [6].

However, the methodology behind the rankings can be criticized. Lin *et al.* [7] discuss the counting method applied to articles and citations, showing that the method has a very large impact on rankings with respect to a given parameter (articles or citations). Whole counting, fractional counting or considering only the first (or corresponding) author can

lead to significant changes. De Mesnard details weaknesses, such as multiple counting in the SCImago ranking in case of several affiliations [8]. Furthermore, several numerical mistakes have been noted in the past, as observed by Holmes [9]. Piro and Sivertsen [10] show the influence of the size-bias in the ARWU, and the potentially huge impact of minor changes in methodology on the overall ranking. In a critical study from 2017, Soh [11] lists common issues of university rankings: the emphasize made on insignificant changes, the neglected influence of indicator scores which can boost a ranking, and other issues due to misuse or misunderstanding of statistical data.

However, these studies focus mainly on problems of methodology without noting major absurdities or disturbing behaviors. The following studies focus more on specific examples. Citations or highly-cited researchers are considered in all three main university rankings. Ioannidis [12] lists extreme examples of self-citations, from fake authors reaching stratospheric h-index to universities deliberately purchasing highly cited researchers. This last phenomena was observed originally by Bhattacharjee in 2011 [13]: two Saudi universities openly admitted that they hire highly-cited researchers in order to increase their ranking in the ARWU. While recruiting top researchers is a respectable strategy to develop a university, targeting only highly-cited ones to increase its visibility in the ARWU is much more concerning. In 2017, Moed [14] pointed some absurdities by comparing five different rankings: for example, only 35 institutions appear in all the top 100 of these rankings; by comparing two rankings, between 49 and 75 universities only will appear in the top 100 of both rankings. He demonstrated as well a bias per country or region depending on the ranking. Furthermore, an advanced analysis was provided by comparing correlation between similar (not to say identical) parameters across rankings, and the lack of correlation between similar parameters is raised. Finally, it was established that the distribution of scores (linear versus exponential) has a tremendous impact on the ranking.

The purpose of this paper is to identify the weaknesses of three rankings and try to identify universities which are potentially exploiting these weaknesses to increase their own ranking. Given their importance, we look into the particular case of the Academic Ranking of World Universities (ARWU), the QS University ranking, and the THE World University ranking in order to understand the challenges and policy issues that make many similar ranking tables questionable and unreliable. In this article, several examples are provided that shed light on inaccuracies of university ranking systems and the possible implications of such inaccuracies for the reputation of universities. Additionally, it is noted that it is possible for universities to manipulate their credentials for exploiting the weaknesses of the ranking systems, enabling them to rank among the best universities in the world. This study sets out tools that can be used to identify overestimated universities. These tools are not assumed to be reliable, must be used carefully, and interpretations based on them must be supported by other data. The study does not intend to be exhaustive but rather aims to identify examples and thereby contribute to the debate on the validity of university rankings. All numerical data, if not specified, are taken from the official websites of the ranking organizations.

II. RANKING PARAMETERS

A. LIST OF PARAMETERS

The main parameters used by ARWU, QS and THE are presented as follows:

ARWU:

- *Alumni* (number of Alumni receiving an NP or FM)
- *Award* (number of faculty members with an NP or FM)
- *HiCi* (number of highly cited researchers on the staff)
- *NS* (number of papers published in Nature and Science)
- *PUB* (number of publications)
- *PCP* (per capita score, the sum of the previous scores divided by the number of faculty members)

QS:

- *Academic reputation* (based on a survey of university staffs regarding reputations of other universities)
- *Employer reputation* (same survey among employers)
- *Faculty/student ratio*
- *Citations per faculty* member
- *International faculty* members, *international students*

THE:

- *Teaching* (reputation, a set of ratios, and institutional income)
- *Research* (reputation, research income and productivity)
- *Citations* (FWCI)
- *Industry income*
- *International outlook* (staff, students, research collaboration)

B. STRENGTHS AND WEAKNESSES OF PARAMETERS

The used parameters have been widely criticized for different and often justified reasons [5]. A first comparison of the parameters is made using previous analysis [5], as well as elements listed in the introduction and considering risks of manipulation. The results are displayed in Table 1.

C. MISUSE OF THE PARAMETERS

In this section, we group the parameters into two categories: non-corruptible and corruptible.

1) NON-CORRUPTIBLE PARAMETERS

Among the parameters in the ARWU, *Alumni*, is not corruptible as it designates a statistic that a given university or individual cannot influence.

TABLE 1. Ranking parameters and its strength and weakness.

Ranking	Indicator	Weight	Weaknesses	Strengths
ARWU	*Alumni*	10%	Benefits old and well-established universities, rough measure, rewards a limited number of fields	Resilient, impossible to game, rewards teaching
	Award	20%	Does not represent all areas, limited number of people	Represents the ability to attract world-class researchers
	HiCi	20%	Focuses mainly on natural sciences, especially biology and medicine-related fields [13]. Encourages universities to hire people just for belonging to this category	Wide pool of high-quality researchers
	NS	20%	Covers mainly natural sciences, does not cover all breakthroughs in research	Journals recognized, represents top quality output
	PUB	20%	Does not consider the quality of work, encourages quantity of publications over quality	Represents the influence and the impact of a university
	PCP	10%	Scant weight, may encourage universities to limit their staffs	Representative of the quality
QS	*Academic reputation*	40%	Human-biased, advantages already established universities, lack of transparency	May eliminate bad universities
	Employer reputation	10%	Similar weaknesses as academic reputation	Emphasizes teaching
	Faculty/student ratio	20%	Easy to game, not representative of quality	Simple
	Citations per faculty	20%	Lack of transparency in weighting when there are several authors, encourages citations within the university	Field-weighted, does not include self-citations or articles with more than 10 authors, represents the impact of research
	International faculties+students (1)	5+5%	Easy to game, not informative about quality, advantages small countries	Provides information on international attractiveness
THE	*Teaching*	30%	Focuses on weaknesses of reputation, faculty/student ratio, other ratios and institutional income (all of them can be gamed)	Diminishes the influence of each internal parameter
	Research	30%	Cumulates Focuses on weaknesses of reputation, research income and research productivity	Diminishes the influence of each internal parameter
	Citations (FWCI)	30%	Self-citations included, as well as article with multiple authors; room for biasing	Field-weighted, represents the impact of research
	International outlook	7.50%	Cf (1), international collaborations can be "bought"	cf (1)
	Industry income	2.50%	Advantages engineering over other fields, depends on national policies	Low weight

Three of the parameters in the ARWU are not easily corruptible or manipulated: (1) *Award*: for example, a university can try to buy a future NP or FM winner; however, we may assume that most of the latter are mainly seeking a strong research infrastructure. Furthermore, it is very difficult to guess future winners; (2) *NS*: there are only a limited number of papers accepted and the competition to publish in these journals is strong; although an example of abuse of this metric has been identified and corrected (not directly linked to ranking issues) [15], this parameter will be considered safe; and (3) *PCP*: again, an issue has been identified: it is possible to increase the ranking of a university by reducing the number of staff [16]. However, the strategy is not sustainable for universities, and if it occurs, it is mostly due to budget cuts.

2) CORRUPTIBLE PARAMETERS

The following parameters can be corrupted if there is a strong will to do so by the administration of the university followed by pressure on faculty (or other entities).

In the ARWU, (1) *HiCi*: similar to Nobel Prizes, *HiCi* researchers can be bought. However, the panel is here much larger (approximately 3,000 researchers), accessible, and the reputation of such researchers is generally less recognized: there is more room for abuse; and (2) *PUB*: all universities now have a tendency to push researchers to publish; however, it may become a dominant priority for a university in order to boost its ranking. By pushing faculty members to publish at any cost, the ranking of a university can be improved at the expense of quality.

In the QS ranking, (1) *Citations per faculty*: this ratio can be biased by universities pushing researchers to cite the work of their colleagues; and (2) *Academic* and *Employer reputation*: the two reputation surveys can also be influenced, as they are perception and human-based.

In the THE ranking, (1) *Industry income* can be biased as a result of policies, thereby increasing the score of a university score; (2) *Research*: a sum of corruptible parameters (reputation, research income and output), (3) *Teaching*: a sum of corruptible parameters (reputation, doctorate-to-bachelor ratio, doctorate-to-staff ratio) and highly corruptible parameters (*staff-to-student ratio*, *institutional income*). However, the ratios balance each other, which makes this metric more difficult to corrupt.

3) HIGHLY CORRUPTIBLE PARAMETERS

The final parameters are considered highly corruptible or can easily be manipulated, as a simple decision of the university administration or an action of a small number of faculty members can have a very large impact on the grading.

In the QS ranking, (1) *Faculty/student ratio*: through a slight alteration of university policy, it is easy to game this parameter (for example, by decreasing the number of students and/or increasing the number of faculty members); and (2) *International faculties, international students*: again, a policy targeting these two groups should be enough to increase the score significantly (by hiring foreigners or implementing an aggressive policy of international students recruitment).

In the THE ranking, (1) *Citations*: the FWCI includes self-citations. It is demonstrated that one individual can have a substantial influence on this parameter [17], [18]; and (2) *International outlook*: this is subject to the same risks as related parameters in the QS. In addition, it encourages universities to multiply international collaborations and simply invite international scientists to put their names on papers, which can be enough to increase the score.

D. CORRELATION BETWEEN PARAMETERS

1) ADJUSTMENTS OF THE GRADING AND FIRST CALCULATION OF CORRELATION

To calculate a first correlation between parameters, we select the 522 universities included in all the 3 rankings for the year 2016 (the ranking is called 2018 in QS, 2017-18 in THE and 2017 in ARWU). We curve the scores for each parameter to distribute them between 0 and 100, using the following formula, where **min** and **max** are the minimal and maximal values for each parameter among all ranked universities.

$$\text{New\_Value} = \frac{(\text{Original\_Value} - \mathbf{min}) * 100}{\mathbf{max} - \mathbf{min}} \quad (1)$$

For the QS ranking, as the lowest values are not displayed, we consider **min** as the minimum value displayed minus 0.1. Olcay and Bulu, who have calculated correlations between rankings [19], obtain correlations between 0.6 and 0.8 for these three rankings. Each parameter is then compared with the weighted sum of all the others (excluding itself), and the correlation coefficients are calculated. The objective is to obtain a first indication of the correlation between parameters. The ARWU parameters are in blue; the QS parameters are in orange; and the THE parameters are in green. The three rankings have the same weights, and the parameters are summed using those weights. The results are displayed in Table 2.

TABLE 2. Correlation between each parameter and all others.

	Correlation	Corruptible?
Research	0.922	Yes
Teaching	0.888	Yes
NS	0.833	No
Academic reputation	0.791	Yes
PCP	0.776	No
HiCi	0.767	Yes
PUB	0.722	Yes
Employer reputation	0.718	Yes
Alumni	0.666	No
Award	0.662	No
Citations per faculty	0.584	Yes
Citations	0.580	Highly
International students	0.463	Highly
International faculties	0.453	Highly
International outlook	0.442	Highly
Faculty/student ratio	0.415	Highly
Industry income	0.295	Yes

From these results, we can distinguish subsequent difference between parameters.

The *Research* and *Teaching* parameters of the THE ranking have very high correlations with the other parameters. This may be explained because of the methodology: these parameters are a combination of other parameters present in this ranking (notably, *reputation*, which has a high weight). The *Teaching* parameter includes, among other parameters, the *reputation* and the *Faculty/student ratio* (65% of the weight); for *Research* parameter, *reputation* and *research productivity* are significant contributors (making up 80% of the weight).

A group of parameters have correlation values between 0.66 and 0.84. It includes all parameters considered non-corruptible together with some that are corruptible. The other parameters have a correlation below 0.59. This group contains all highly corruptible parameters together with some that are corruptible. Outside of the first group, we see here a negative link between the corruptibility of a parameter and its correlation with other parameters. This is of course not sufficient to draw conclusions about the non-relevance of any given parameter, but it confirms our interest in investigating several of these parameters. A low correlation combined with a corruptible profile makes a parameter relevant to investigate.

2) MATRIX OF CORRELATIONS BETWEEN PARAMETERS

A matrix of correlations between all the parameters is then constructed (Table 3). The colors indicate the strength of the correlation, from highest to lowest:

TABLE 3. Correlation between various parameters using in ranking.

	Award	HiCi	NS	PUB	PCP	Ac. reput.	Cit./fac.	Empl. reput.	Fac/stud.	Intern. Fac	Intern. stud	Teach	Res	Cit.	Industr.	Intern. Out
Alumni	0.80	0.55	0.75	0.50	0.66	0.55	0.34	**0.43**	**0.38**	0.20	0.26	**0.66**	0.62	0.40	0.09	0.21
Award		0.59	0.77	0.49	0.73	0.54	0.39	0.41	0.37	0.24	0.26	0.65	0.63	0.41	0.07	0.23
HiCi			0.79	0.66	0.69	0.60	0.51	0.46	0.38	0.38	0.35	0.68	0.71	0.61	0.20	0.35
NS				0.70	0.77	0.67	0.52	0.51	0.39	0.31	0.31	0.79	0.78	0.62	0.13	0.30
PUB					0.53	0.74	0.41	0.55	0.31	0.19	0.13	0.72	0.73	0.38	0.31	0.12
PCP						0.59	0.59	0.47	0.39	0.43	0.39	0.67	0.71	0.56	0.23	0.40
Ac. reput.							0.48	0.83	0.36	0.32	0.34	0.81	0.82	0.41	0.27	0.31
Cit./fac.								0.40	0.11	0.36	0.32	0.57	0.66	0.48	0.34	0.28
Empl. reput.									**0.32**	0.36	0.41	**0.69**	0.70	0.28	0.27	0.35
Fac/stud.										0.13	0.17	**0.52**	0.42	0.24	0.21	0.11
Intern. Fac											0.73	0.27	0.40	0.45	0.07	0.85
Intern. stud												0.30	0.40	0.46	0.00	0.81
Teach													0.92	0.50	0.32	0.23
Res														0.57	0.41	0.37
Cit.															0.01	0.57
Industr.																0.00

- 0.8 and higher: dark green (very high correlation)
- 0.6 to 0.79: clear green (high correlation)
- 0.4 to 0.59: no color (average correlation)
- 0.2 to 0.39: clear orange (low correlation)
- 0.19 and below: dark orange (very low correlation)

a: ANALYSIS WITHIN EACH RANKING

In this section, the correlations corresponding to specific rankings are framed. Let us first analyze the correlations between parameters in each ranking. For the ARWU, correlations between parameters are on average strong. The lowest scores are found when either *HiCi* or *PUB* are involved. Interestingly, these are also the only two parameters identified as corruptible in the analysis. For the QS ranking, we observe a correlation of 0.83 between academic and employer reputation, which is easily understandable but raises the question of the influence of one parameter on the other. A high correlation is found between *International faculties* and *International students*, again easily understandable.

However, the correlations between other parameters are low. The *Faculty/student ratio* and *International faculties* have the lowest correlations within this ranking, and both of them are considered highly corruptible.

For the THE ranking, the correlation between the *Teaching* and *Research* parameters is very high. This is understandable, as they use the same academic survey for, respectively, 50% and 60% of their total weight. Additionally, the lowest correlations are for *Industry income* and *International outlook*.

b: ANALYSIS ACROSS RANKINGS

Let us now seek to identify significant correlations across rankings. The parameters that specifically reflect teaching are marked in bold in Table 3.

- There is a strong correlation (0.66) between *Teaching* (THE) and *Alumni* (ARWU) but a low one between *Alumni* and *Faculty/student ratio* (QS). This last point may be explained by the delay between having a degree and receiving an NP or FM; however, one may assume that most universities provide future NPs and FMs with long-term strategies that do not vary much over time;
- The correlation between *Teaching* (THE) and *Faculty/student ratio* (QS) is average, which is surprising, as *Teaching* (THE) includes the *Faculty/student ratio* itself. It is, however, the strongest correlation that can be found for the *Faculty/student ratio*;
- The *Employer reputation* (QS) correlates well with *Teaching* (THE) but less with *Alumni* (ARWU).

Parameters that specifically reflect the research are underlined:

- The *Academic reputation* (QS) and *Research* (THE) correlate rather well with the other research parameters and very well with each other;
- The dependency is average between *HiCi* and *Award* (ARWU) on the one hand, and between *Citations* (THE) and *Citations per faculty* (QS), on the other hand;
- More surprisingly, *Citations* (THE) and *Citations per faculty* (QS) are not strongly related. This is the same parameter with slight differences in methodology (i.e. differences in self-citations or articles with large numbers of authors), this at least shows a significant influence in the choice of these parameters;
- In general, these two Citations parameters correlate poorly with the others.

Comparisons involving non-teaching or research parameters follows:

- The correlations between *Industry income* and all other parameters are low or very low, raising the issue of the pertinence of this parameter;
- Similarly, *International outlook* (THE) has low correlations with all other parameters, except the two international parameters in the QS ranking. The two international parameters from QS, similarly, are not well correlated with any other parameters, apart from the international ones. This finding calls into question the impact and relevance of advanced internationalization as part of a university strategy, especially if this strategy is imposed rather than a natural advancement. The data confirm that several parameters should be carefully investigated. It was decided to focus on the parameters for each ranking that are most corruptible relative to the others.

The selected parameters for each ranking as a result of this correlation analysis are:

- ARWU: *HiCi* and *PUB*.
- QS: *Faculty/student ratio* and *international* parameters.
- THE: *Citations*, *International outlook* and *Industry income*.

III. A METHOD TO DETECT POTENTIAL ABUSES OF RANKINGS

One way to detect potential gaming of rankings is to investigate the weight of one or several corruptible parameters in a given ranking and observe how much this weight has evolved in recent years.

A. ARWU

1) INVESTIGATION OF HiCi AND PUB PARAMETERS IN THE ARWU

In our study, the most recent ARWU data (2017) are used for the analysis. The sum of scores for *HiCi* and *PUB* (40% of the total weight) divided by the total score is calculated, and universities are ranked according to this criterion. We call this number "*ratio A*."

First observation: of the top 20 universities in this new "ranking," 12 are from China, and 2 are from Saudi Arabia. No other country is represented more than once in this "top 20." All these universities improved their ranking the last five years, most of them significantly. Notice that all the Chinese universities but one in the ARWU are in the top half (top 250) in terms of this ratio. Of the 20 "last" in term of *ratio A*: 8 are in the USA, 7 are in France, and 6 are members of the top 10 in the general ARWU. 16 of these universities have seen their ranking decreasing between 2012 and 2017 while 4 were marginally improving.

From these data, several conclusions emerge:

- Universities that score mainly on *HiCi* and *PUB* in 2017 have seen their rankings increase over time;
- Universities scoring mainly on other parameters have a stable or decreasing ranking.

Most Chinese universities have a high *ratio A*, while French universities score quite low. It is important to note that in China, researchers are financially rewarded for publications [20], while in France, there is no monetary incentive, and professor positions are mainly tenured with fixed salaries (so they have no interest in publishing in low-quality journals). As a (probable) consequence, the performance of Chinese universities in this ranking relies on numbers of publications, while the performance of the French universities relies on most of the other factors (that is, *Alumni*, *Awards*, *NS* and *PCP*) but not *HiCi*.

Furthermore, the top 20 universities in terms of the *ratio A* have an average *PCP* score (quantifying the quality of research) of 17.3. The bottom 20 has an average of 43. By taking the top and bottom 100, we obtain *PCP* averages of 19 and 32.1, respectively. It can be concluded that, on average, universities awarded high scores in *HiCi* and *PUB* do not focus on quality, while universities with low *HiCi* and *PUB* scores have much higher *PCP* scores.

By putting significant effort into increasing the number of publications (regardless of quality) and/or affiliating heavily cited researchers, a university can dramatically improve its ranking, despite the absence of an intention to develop science and high quality research.

2) INVESTIGATION OF THE PUB PARAMETER IN THE ARWU

We now investigate the possibility of bias in the *PUB* parameter. First, by ranking universities by *PUB* score, we observe that in the new "top 12," all universities are in the global top 24 in the ARWU, except 3, which are ranked beyond the top 100: the University of Sao Paulo, Shanghai Jia Tong University and Zhejiang University. The differences in their global rankings show that they benefit highly from this parameter.

From the rankings 13^{th} through 100^{th}, six universities do not belong to the ARWU top 300: Tongji, Wuhan, Tianjin, Central South, Jilin and Shandong Universities, all in China. The *FWCI* (Field-Weighted Citation Impact) measures the average impact of a university compared with others. It is a recognised metric to measure the average impact of publications from a given university: 1 is the average value in the world, the best universities are generally close to or over 2. Now, let us examine the *FWCI* (August 2017) for the universities cited above. They are ranked by score in *PUB* in Table 4.

TABLE 4. Universities relying on *PUB* score in the ARWU (Top 100).

University	FWCI	Country
University of Sao Paulo	1.04	Brazil
Shanghai Jia Tong University	1.13	China
Zhejian University	1.11	China
Shandong University	1.01	China
Jilin University	0.88	China
Central South University	1.00	China
Tianjin University	0.96	China
Wuhan University	1.09	China
Tongji University	0.96	China

Note that a high *FWCI* is not necessarily a mark of quality, although a low score implies that the quality of research is low. The *FWCI* for the universities are calculated based on the number of citations they receive relative to a given field, however, it also includes self-citations. The *FWCI* for these universities range from 0.88 to 1.13, which is around the world average and in any case far to what is expected from a world-class university.

All of these universities clearly have the resources to do quality research, but their focus appears to be more on quantity than quality. This is perhaps the downside of the publish or perish model, growing the *PUB* significance can become a major strategic goal for a given university for improving its ranking. It is difficult to judge the influence of this ranking on the policies of the individual universities, but it is evident that the ranking pushes them up, despite an average quality of research. The advisability of awarding a good score to such universities, privileging quantity over quality, is questionable. It may encourage universities to publish as many papers as possible in an academic world already saturated with published articles [21].

On the other hand, several universities originally in the top 100 score low in *PUB*: Rockefeller University (ranked 488^{th} in *PUB*, with an *FWCI* of 2.99); the Ecole Normale Supérieure Paris (ranked 425^{th}, with an *FWCI* of 1.80), or the

University of California Santa Cruz (ranked 416^{th}, with an *FWCI* of 2.48). These universities are penalized by the *PUB* parameter despite having *FWCI* values much higher than universities advantaged by the parameter.

If we have a closer look at the average *PUB* score at a country scale: from 2004 (=43) to 2017 (=45.9), it has been constantly high for ranked Chinese universities. For Saudi universities, the average *PUB* score went from 19.7 to 36 between 2010 and 2017 (note that 3 and 4 universities respectively are ranked for this country).

3) INVESTIGATION OF THE HiCi PARAMETER IN THE *ARWU*

The quest for higher ranks has prompted many more universities to find ways to beat the system due to pressures from various stakeholders. For example, the average *HiCi* score for Chinese universities was 0 in 2004, 0.3 in 2010 and 11.6 in 2017, and this is despite the increasing number of Chinese universities in the ranking. In Saudi Arabia, the average *HiCi* score went from 22.7 to 36.8 between 2010 and 2017. In both cases, the universities in these countries were able to attract highly cited researchers at an impressive scale. The question of whether a political strategy is being used to increase the ranking, voluntarily or not, at the scale of a given country, can thus be raised.

A careful look at the *HiCi* parameter reveals another worrying factor: all the universities ranked in the top 20 according to *HiCi* score are in the top 26 of the general AWRU ranking, except King Abdulaziz University, which is ranked above 100^{th}. Among all highly cited researchers, 520 (about 17% of all highly cited researchers) have a double affiliation (August 2017) [22]. King Abdulaziz University is the first affiliation of 29 of its highly cited researchers and the second (or more) affiliation of 41 others. Furthermore, 96% (67/70) of this university's highly cited researchers have a double affiliation [22]. This university attracts about 2% of the highly cited researchers in the world, but more than 13% of those with a double affiliation (about 0.1% of those with one affiliation only), and 9% of researchers who are listed in more than one field (13 out of 142). Although the *ARWU* considers only the first affiliation, questions can be raised concerning the sudden interest of this university in highly cited researchers, especially those with more than one field of expertise. This clearly shows that universities around the world are successfully adopting strategies to unrealistically boost their rankings; such practices, in turn, make the ranking list meaningless and untrustworthy for policy makers and students. Issues concerning that university have been raised by several experts (cf. Introduction) and relayed, ironically, by the THE network [23].

4) INVESTIGATIONS ON NOTABLE IMPROVEMENTS IN RANKING

Among the top 200 universities in 2017, Tsinghua and Peking Universities (top 100), King Abdulaziz and Nanyang Technological Universities (101-150), China Medical University, Curtin University and Harbin Institute of Technology (151-200) have made the most significant improvements in their rankings since 2012 relative to their current positions (excluding universities created by strategic mergers and acquisitions). For example, Tsinghua moved from 151-200 in 2012 to 48 in 2017, while King Abdulaziz University moved from 301-400 in 2012 to 101-150 in 2017. A closer look at the data of these seven universities shows some interesting trends between 2012 and 2017. In comparison to the corresponding average scores of the top 500 universities in the 2017 ranking, the average scores of the aforementioned seven universities on *Alumni* and *Award* is much lower (*Award* is equal to 0 for all of them), and their average *NS* score is now slightly above. Their average *PUB* score continued to increase from 42.3 to 52.5 and is now largely above the top 500 average of 40.3. Their average *HiCi* score was far below average five years ago with a value of 5.5 and is now 33.7, far above the top 500 average value of 18.2.

As a case study, during this 5-years period, the *HiCi* scores of Nanyang Technological and Tsinghua Universities went from 0 to 37.8, and the *PUB* score of King Abdulaziz University from 23.2 to 46.4.

Among these seven universities, on average, 83% of their score (excluding *PCP*) relies on the *HiCi* score and *PUB* score, compared to 69% of the overall average within the top 500 ranked universities. Finally, 80% of the increase in their overall scores (excluding *PCP*) comes from their increasing scores on *PUB* (21%) and *HiCi* (59%). To make a significant move up in the ranking, the most effective strategy seems to be combining intensive hiring of highly cited researchers with an increasing number of publications, regardless of the quality of those publications.

When we evaluate performance relative to quality, several questionable factors emerge. For example, Tsinghua and Peking universities have a *FWCI* of 1.36 and 1.40, two of the five lowest among the top 100 universities of the ARWU. The *FWCI* values of China Medical University (0.84) and Harbin Institute of Technology (0.99) are very low too, especially compared to what is expected for a top 200 university.

5) OBSERVATIONS ON THE *PCP* PARAMETER

Finally, the *ARWU* displays the parameter called *PCP*, the per capita ratio. It is odd that this parameter receives no media emphasis, as it is the closest to a measure of quality among all the parameters used in the three rankings.

Among the most notable jumps compared to the original ranking, Caltech rises from 9^{th} to 1^{st}, the Ecole Normale Supérieure Paris from 69^{th} to 2^{nd}. The most notable declines are Rutgers University from 79^{th} to 349^{th}, King Saud University from 101-150 to 366^{th}, and King Abdulaziz University from 101-150 to 374^{th}.

Among the original top 50, New York University falls from 29^{th} to 251^{st}. Among the original top 15, the University of Washington falls from 13^{th} to 69^{th}. These changes show, among other things, how sensitive the ranking is to whether we consider the impact or the quality of the output

TABLE 5. Universities listed based on the *Ratio A*.

University	Ratio A	FWCI	Papers in top 10% SNIP journals (%)
Universiti Brunei Darussalam (UBD)	0.79	1.42	13.4
National Research Tomsk Polytechnic University	0.76	1.53	6.4
National Research Nuclear University MEPhI (Moscow Engineering Physics Institute)	0.74	1.28	11.4
University of Troms? The Arctic University of Norway	0.69	1.74	21.6
Moscow State Institute of International Relations (MGIMO University)	0.69	0.44	6.1
Moscow Institute of Physics and Technology (MIPT / Moscow Phystech)	0.67	1.21	13.7
Tomsk State University	0.65	1.02	10.1
Qatar University	0.65	1.46	26
University of Colorado, Denver	0.65	2	32.7
Universidad de Belgrano	0.65	1.01	13.1
Lincoln University	0.64	1.33	25
HUFS - Hankuk (Korea) University of Foreign Studies	0.64	0.74	11.8
Tokyo Medical and Dental University (TMDU)	0.61	1.32	19.2
L.N. Gumilyov Eurasian National University (ENU)	0.61	0.61	8.6
University of Dundee	0.61	2.04	33.2

of universities. By slightly modifying the parameters of the ranking to make them more quality-oriented, we may observe a drastic reduction in numbers of papers and a significant increase in average quality. As a result, research activity worldwide may dramatically improve along with the image of universities in public opinion.

6) PRELIMINARY CONCLUSIONS

Universities experience various indirect or direct pressures from governing and funding bodies to increase their rankings, where the ranking of universities is seen as a matter of prestige and reputations. The universities adopt several strategies such as hiring highly-cited researchers and providing monetary rewards for publications. This trend is observed in the rise of the *HiCi* scores and the *PUB* scores of the universities that managed to increase their ranking dramatically.

We have identified several universities that benefit significantly from *HiCi* and *PUB*. Note that this list is not exhaustive, as other methods may be efficient as well in detecting universities that potentially benefit from weaknesses of the ARWU. The influence of the ARWU on the policies of some of these universities can be questioned. The fact that the ranking is published yearly by one of these universities (Shanghai Jiao Tong) indirectly points to a conflict of interest: the university is among the top universities in *PUB*, and since this parameter encourages quantity over quality, it amplifies and encourages the publish or perish model.

B. QS UNIVERSITY RANKING

1) INVESTIGATION OF THE STUDENT/FACULTY RATIO AND INTERNATIONAL FACULTIES AND STUDENTS

For the QS ranking, we use as well data published in 2017 (called 2018 on their website). The technique described previously is adapted, as not all the data are displayed for all the universities. Indeed, the low scores for each parameter are not displayed and must be considered equal to 0 in the coming calculations. However, some of the universities deserving investigation can still be identified, thanks to their high (and thus displayed) scores on the targeted parameters.

Only the total scores of the top 400 universities in the QS are displayed. That is why it is more reliable to work first on these universities. The first step is to identify universities among the top 400 that rely mostly on the *Faculty/student ratio*, *International faculties* and *International students* (for example, by reducing the number of local students to mathematically increase the *Faculty/student ratio* and the *International students* score).

By dividing the sum of these 3 parameters by the total score, we will have an accurate estimate (if the 3 pieces of data are displayed) or a minimal estimate (if only 1 or 2 of these pieces of data are displayed) of the weight of the 3 parameters mentioned above in the total score. We call this ratio: *ratio B*. The total weighting of these parameters is 30%: the top 15 universities (*ratio B* $> 60\%$) are identified.

None of the 3 parameters discussed in the previous paragraph concern research: it is then decided to add in the number of publications and the *FWCI* for each of these universities. These two numbers should indicate whether research at these universities is acceptable. We compare these 15 universities by examining their *FWCI* scores and the proportion of papers from each that appears in the top 10% of journals, according to *SNIP*. Like the *FWCI*, the *SNIP* is a metric that weights per field the impact of a paper or journal (instead of a university). The results are displayed in Table 5.

Approximately 18.2% of the articles are published in the top 10% of journals worldwide, as judged by *SNIP*. A deeper investigation is then conducted on universities from Table 5 that have fewer than 10% of papers in the top 10% of *SNIP* journals and a *FWCI* below 1. Indeed, such parameters indicate poor quality research not corresponding to a top 400 university, as one may imagine.

Two universities, i.e. Moscow State Institute of International Relations and L.N. Gumilyov Eurasian National University are then selected, marked in orange in Table 5. For these universities, numbers of papers published since 2012 are obtained, using SciVal [24]. Numbers of members of academic staffs are also investigated, the numbers are taken from Wikipedia and Wikiwand [25], [26]. The number of papers per faculty and per year, as well as the number of

TABLE 6. Case study of universities with low *FWCI*.

University	Faculties	Papers 2012-17	Paper/(Faculty.year)	Faculty.year/paper
Moscow State Institute of International Relations	1432	242	0.028	35.5
L.N. Gumilyov Eurasian National University	1678	1301	0.129	7.8

TABLE 7. Case study: comparison of Kazakhstan universities.

University	FWCI	Papers 2012-17	QS ranking (2017-18)	Preceding in the QS ranking
Al-Farabi	0.47	1695	236	Universities of Leicester, of Paris-Sud, of Miami
Eurasian L.N. Gulmilyov (already discussed previously)	0.61	1301	336	Virginia Tech, George Washington University
KazNTU - Satpayev	0.47	482	411-420	Universities of Connecticut, of Pisa, of Maryland
Kazakh National Pedagocial - Abai	0.39	307	491-500	Universities of Lyon 1, of Leipzig, of Cincinnati
South Kazakhstan - Auezov	0.24	383	501-550	Universities of Bayreuth, of Oregon
Karaganda State University	0.28	224	651-700	Universities of Central Florida, of San Francisco
KBTU	0.29	268	651-700	
World languages - Ablai Khan	0.21	49	801-1000	

years for one paper per faculty are calculated. The results are displayed in Table 6.

The numbers of publications per faculty is 1 paper every 8 years and 1 paper every 36 (!) years per faculty member for these universities, including papers with multiple authors. Although a high number of papers does not mean that a university is world-class, such low outputs are not acceptable for a top 400 university. One may argue that most scientists at these universities publish in Russian-language journals. While this is probably true, here we are considering world rankings; and the low research output cannot explain the very low *FWCI* (although a high *FWCI* is not necessarily a mark of quality, a low one means that the quality of research is low).

The Moscow State Institute of International Relations and L.N Gumilyov Eurasian National University appear in the top 400 universities in the QS ranking, but their very poor research output both in numbers and quality should have disqualified them from being considered in such rankings.

2) THE SPECIAL CASE OF KAZAKH UNIVERSITIES

Unlike most western universities that have a high activity of research and teaching, the former USSR universities focused heavily on teaching. The research in former USSR university system was separated and often done within specialized research institutes. Kazakhstan largely inherited this system of education, with professors and doctors considered as offering services and often underpaid. The lower salaries of academics in Kazakhstan universities makes it a demotivating environment for talented PhD graduates to join academia, and those who end up taking up those positions are forced to take up multiple jobs. In some forms, the need for extra money also leads to corruption, as stated by Sarinzhipov [27].

One of the attempts to revive the higher educational system in Kazakhstan was attempted by starting internationally competitive universities such as Nazarbayev University. It should be noted that Kazakhstan has the lowest citation rate per paper [28] and one of the lowest *FWCI* (=0.57) in the world [24]. This makes the development of world-class universities in this region a significant challenge. However, interestingly, eight universities from Kazakhstan are featured in the QS ranking.

A closer inspection of these eight Kazakh universities that feature in the QS ranking reveals interesting weaknesses of the QS ranking. None of these eight Kazakh universities appear in the ARWU, the THE rankings, or in the top 400 of the QS specific field rankings. It appears that these universities rely heavily (if not exclusively) on their *Faculty/student ratio* scores. However, the quality of research outputs from these universities appear to be low.

All of the Kazakh universities in Table 7 except Eurasian L.N. Gumilyov have *FWCI*s below the 0.5, indicating low field specific citation profile. While most of these universities have published more than 200 papers, their quality has been low. The Ablai Khan University of World Languages has the lowest *FWCI* between 2012 to 2017 with a total of merely 9 citations (including self-citations). This raises the question of validity of QS ranking.

It can be seen from Table 8 that the *Faculty/student ratio* among most of these universities has been rising in recent years. The low faculty salaries in Kazakhstan present an opportunity for universities to hire more faculties, thereby, increasing the *Faculty/student* ratio. This way they are able to potentially exploit one of the weakness of QS ranking. On the other hand, the focus on increasing quantity of the faculty hires with low salaries often does not help with hiring internationally visible research-oriented faculties to these universities. Even under this dire situation, several universities present the QS ranking in their official web-pages [29].

3) PRELIMINARY CONCLUSIONS

Imposing minimum standards of quantity and quality of output may limit the potential abuse of QS ranking weaknesses. The relevance of a crude faculty/student ratio as the only parameter for teaching must be seriously discussed. Transparency of the data may help to avoid misinterpretation of the scores.

TABLE 8. Case study: faculty/student ratio over time for Kazakhstan universities.

	Grade Scores for faculty/student ratio over time					
University	**17-18**	**16-17**	**15-16**	**14-15**	**13-14**	**12-13**
Al-Farabi	99	96.9	92.2	84	91.3	84.4
Eurasian - Gulmilyov	98.2	99.6	99.9	99.8	99.7	99.3
KazNTU - Satpayev	97.1	93	86.7	75.9	58.4	53.1
Kazakh National Pedagocial - Abai	92.6	86.7	79.8	68.2	53	60.7
South Kazakhstan - Auezov	82.5	69.5	59.7	64.5	70.9	65.5
Karaganda	59.7	56.2	54.4	45.8		

C. THE WORLD UNIVERSITY RANKING

For THE, we use the data published in 2017 (called 2017-18), unless specified. THE limits the problems encountered by the QS ranking by requesting a minimum of 1,000 papers per year (which may still include a couple of the universities criticized in the previous section).

THE ranking parameters are however also prone to abuse. Large number of self-citations from a faculty member can significantly change the ranking of the university [17], [18]. As a case study, Vel Tech University appears 43rd in the Asia ranking (data from 2016), but is removed from the THE world ranking despite the fact that all the other universities in the top 80 in Asia are included in the world ranking. Further, THE ranking requires the universities to have an undergraduate program to appear in the ranking. However, there is at least one university in the ranking that lacks an undergraduate program (the Tata Institute of Fundamental Research) [30]. These inconsistency in the criteria raises questions on the audit mechanisms adopted to ensure the accuracy of the THE ranking.

The score of two parameters in THE ranking system to the total score are calculated, and universities are ranked in accordance with their score in *International outlook* and *Industry income*. In the new top 50, 16 of the universities are ranked 200 and above in the general ranking (including the two universities from Saudi Arabia previously discussed).

Ranking universities according to their scores in *Industry income*, we find that of the 30 best scores, 16 are ranked 200 or below in the original ranking. Similarly, of the 30 best scores in *International outlook*, 14 are ranked below 200 in the original ranking. These simple examples raise the question of whether a university can raise its ranking just by scoring very high on a secondary criterion. A limitation on the weight of each criterion in the total score, if not already included, could help to limit such variations.

D. COMPARISON OF SIMILAR PARAMETERS ACROSS RANKINGS

In this section, a comparison between QS and THE rankings data is provided using the data from 2017. When taken from the ranking, the adjusted data (for both Citations parameters, and Faculty/student ratio and International students scores for QS) are used. The real scores are used when showing specific examples.

1) THE FACULTY/STUDENT RATIOS

As the *Faculty/student ratio* is considered in two rankings (graded by QS, displayed by THE on their website), it would be interesting to see to what extent these rankings correlate (and so agree) with each other. The comparison is made for about 500 universities displayed in both rankings. The results are presented in Fig. 1.

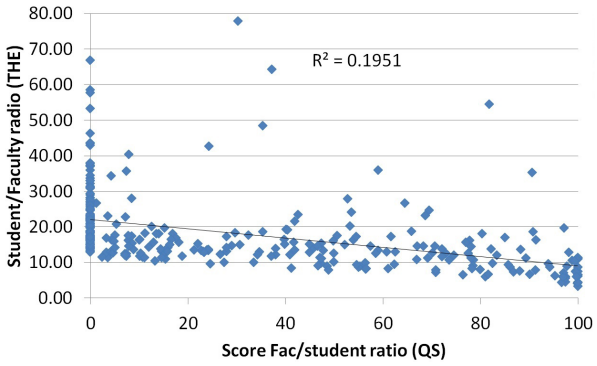

FIGURE 1. The correlation of the *faculty/student ratio* between THE and QS ranking systems.

While the trend line is expected to fall (assuming linearity), the distribution of the points shows large disagreement between the two rankings, even though they treat the same data. At least one of these rankings is fundamentally wrong on this parameter.

For example:

- The University of Washington is rated 28/100 in QS, while THE displays an very good ratio of 11.4 students per faculty;
- Similarly, the Indian Institute of Science is graded only 56.1/100 by QS despite having 8.4 students per faculty according to THE;
- On the other side of the graphic, the University of Bonn is rated 47.9/100 in QS, although it has only 1 faculty member per 77.9 students according to THE;
- The university of Antwerp is rated 93/100 in QS while THE displays 35.2 students per faculty

2) CITATIONS

Citations per faculty is used in QS ranking and overall Citations of the university in terms of FWCI is used in the THE ranking. The QS ranking excludes self-citations, while THE does not. Both parameters are field-weighted. We have seen

already in Section I that the correlation was only 0.43 for the 522 universities ranked in the three rankings. The visual representation confirms the situation (Fig. 2).

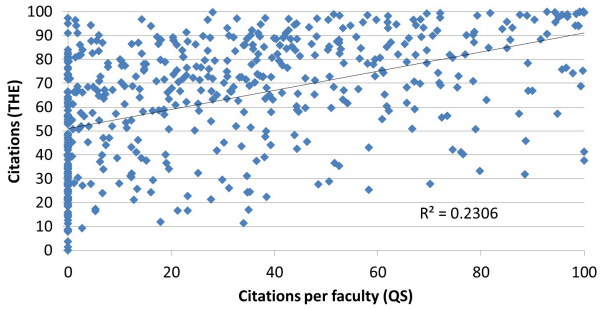

FIGURE 2. The correlation of the *citations* parameters between THE and QS ranking systems.

Figure 2 shows either that the choice of methodology has a tremendous effect on the score or that at least one of the rankings is fundamentally wrong. Among extreme cases, let us note the Gwangju Institute of Science of Technology (100/100 for QS, 40.9/100 for THE) or New York University (23.4/100 for QS, 96.5/100 for THE). Such differences cannot be explained.

3) INTERNATIONAL STUDENTS

The final comparison is between the score for *International students* (QS) and the rate of *International students* (THE) displayed on their website (Fig. 3).

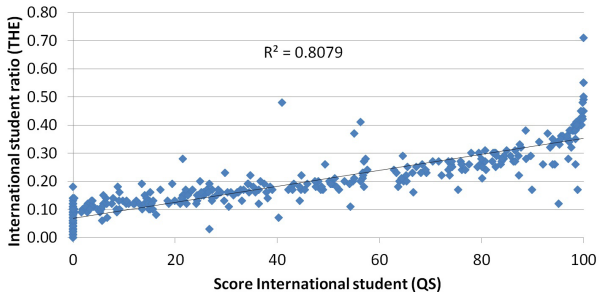

FIGURE 3. The correlation of the *international students* parameter between THE and QS ranking systems.

The correlation is close to what we expected for the *Citations* and much better than in the comparisons of the two previous sets of parameters. However, several points are far off the trend line, indicating at least a number of individual errors. For example, Murdoch University has a 48% rate of international students, according to THE, but scores only 53.6/100 in QS (it should score easily 100 if the THE data is correct). On the other side, James Cook University scores 96.2/100 in QS despite having only a 12% rate of international students according to THE. Both universities are in the same country (Australia).

4) PRELIMINARY CONCLUSIONS

Major incoherences can be observed across the QS and THE rankings. Due to a lack of transparency about the parameters employed, it is difficult to determine where the problems lie. However, it is clear that the two rankings use completely different sets of data for at least some universities, if not the majority. The issues raised should encourage the two rankings to publicly disclose their data and sources. If they prefer not to do so to avoid future gaming, it will be an implicit but direct concession of the unreliability of their work and the lack of resilience of their respective ranking.

IV. CONCLUSION

This study raises major issues concerning academic rankings. Promotion of quantity over quality, tolerance for academic misconduct, promotion of very low-quality research universities, promotion of abuse of self-citations and a lack of professionalism, sources identification and transparency while processing the data are all demonstrated here. In addition, inconstancies among rankings for similar parameters raise heavy suspicion of unreliability. All of these behaviors have nothing to do with the academic world, and it is highly ironic that these university rankings are so widely consulted, despite a lack of adherence to the most basic academic principles. What we see is that university ranking systems are heavily focused on quantitative measures that can be manipulated one way or another to boost the ranking of a university. Through this process, universities can spend their resources and efforts on improving those parameters, while forgetting the goal of intellectual inquiry that is their reason for existing. Furthermore, does it matter whether a university is ranked? In fact, it may not matter in the long run, but for now, this is a question raised by national policies that are using competition and direct pressure to demand that universities increase their rankings to gain international recognition and reputation.

Unfortunately, universities are now prisoners of these rankings and are slowly being pushed to improve their rankings rather than the quality of their work. Universities are supposed to produce and distribute knowledge to the future elite of our planet, but rankings are highly misleading and distort the public opinion. Universities are supposed to produce and distribute knowledge to the future elite, but these rankings may mislead both political leaders and public opinion. The current ranking system promotes unethical behaviors, and universities that game the system can be highly rewarded thanks to the free advertising of the rankings. Minimum requirements for quality and zero-tolerance for misconduct must be the absolute minimum included in any ranking.

This article put an emphasize on issues from universities in Middle-East, former USSR countries and China; the statistical analysis of data reveals a general country-scale trend. However this analysis is not exhaustive and other concerning issues may be pointed out by continuing investigations. None of the three main rankings is safe from these abuses; however the QS ranking seems to be the most exposed, and so the less reliable. Furthermore, a conflict of interest is raised for the ARWU, as the university in charge of it is benefiting from one of its weaknesses.

This article shows that if the only objective of a university administration is to improve the ranking of their university, it is possible to do so by simply combining the following parameters: pressure faculty to multiply articles, buy highly

cited researchers, share publications with international collaborators, encourage self-citations or citations within the university, maintain a high Faculty/student ratio, hire international staff and recruit international students. The focus of universities on improving their rankings by pressuring faculties for multiple articles and buying highly cited researchers, among other tactics, could lead to the misuse of resources, especially in developing universities that must conform to the ambitions of the administration. Once the score becomes the target, it is no longer relevant.

It is time for the ranking organizations to take appropriate measures to retain their credibility and fight against the misconduct documented in this article rather than promoting inappropriate behaviors and jeopardizing the system. Rankings must be as reliable and incorruptible as possible. Universities shape the future of humankind, and such biases cannot be tolerated by the academic world and the public opinion.

REFERENCES

[1] (Oct. 2015). *12 Years With Global University Rankings—A Panoramic (Re)view and an Update on Recent Developments*. [Online]. Available: http://www.aca-secretariat.be/index.php?id=822
[2] A. Rauhvargers, "Global University rankings and their impact," Eur. Univ. Assoc., Brussels, Belgium, Tech. Rep., Jun. 2011, accessed: Jan. 2018. [Online]. Available: http://www.eua.be/Libraries/publications-homepage-list/Global_University_Rankings_and_Their_Impact.pdf?sfvrsn=4
[3] (Sep. 2017). *Veltech University*. [Online]. Available: https://www.timeshighereducation.com/world-university-rankings/veltech-university#ranking-dataset/608682
[4] T. Sidorenko and T. Gorbatova, "Efficiency of Russian education through the scale of World University rankings," *Procedia-Soc. Behavioral Sci.*, vol. 166, pp. 464–467, Jan. 2015.
[5] M. Saisana, B. d'Hombres, and A. Saltelli, "Rickety numbers: Volatility of university rankings and policy implications," *Res. Policy*, vol. 40, no. 1, pp. 165–177, 2011.
[6] J. Horstschräer, "University rankings in action? The importance of rankings and an excellence competition for university choice of high-ability students," *Econ. Edu. Rev.*, vol. 31, no. 6, pp. 1162–1176, 2012.
[7] C.-S. Lin, M.-H. Huang, and D.-Z. Chen, "The influences of counting methods on university rankings based on paper count and citation count," *J. Informetrics*, vol. 7, no. 3, pp. 611–621, 2013.
[8] L. De Mesnard, "On some flaws of university rankings: The example of the scimago report," *J. Socio-Econ.*, vol. 41, no. 5, pp. 495–499, 2012.
[9] R. Holmes, "The THE-QS World University rankings, 2004–2009," *Asian J. Univ. Edu.*, vol. 6, no. 1, pp. 91–113, 2010.
[10] F. N. Piro and G. Sivertsen, "How can differences in International University rankings be explained?" *Scientometrics*, vol. 109, no. 3, pp. 2263–2278, 2016.
[11] K. Soh, "The seven deadly sins of World University ranking: A summary from several papers," *J. Higher Edu. Policy Manage.*, vol. 39, no. 1, pp. 104–115, 2017.
[12] J. P. A. Ioannidis, "A generalized view of self-citation: Direct, co-author, collaborative, and coercive induced self-citation," *J. Psychosomatic Res.*, vol. 78, no. 1, pp. 7–11, 2015.
[13] Y. Bhattacharjee, "Saudi universities offer cash in exchange for academic prestige," *Science*, vol. 334, no. 6061, pp. 1344–1345, 2011.
[14] H. F. Moed, "A critical comparative analysis of five World University rankings," *Scientometrics*, vol. 110, no. 2, pp. 967–990, 2017.
[15] S. Chen. (Apr. 2017). *Science Journal Retracts 107 Research Papers by Chinese Authors*. [Online]. Available: http://www.scmp.com/news/china/society/articl/2089973/science-journal-retracts-107-research-papers-chinese-authors
[16] S. Saarenketo, "Like it or not, University rankings are here to stay," Tech. Rep., Oct. 2014, accessed: Jan. 2018. [Online]. Available: https://www.lut.fi/web/en/news/-/asset_publisher/lGh4SAywhcPu/content/like-it-or-not-university-rankings-are-here-to-stay
[17] M. Mussard and A. James, "How to boost the ranking of your university using self-citations? An example of the weaknesses of university ranking systems," *Current Sci.*, vol. 113, no. 10, p. 1827, Nov. 2017.
[18] B. Sowter. (Mar. 2017). *How did Vel Tech University Get Such a High Rank on the Top Asian Universities List?* [Online]. Available: https://www.quora.com/How-did-Vel-Tech-University-get-such-a-high-rank-on-the-top-Asian-universities-list
[19] G. A. Olcay and M. Bulu, "Is measuring the knowledge creation of universities possible?: A review of university rankings," *Technol. Forecasting Social Change*, vol. 123, pp. 153–160, Oct. 2016.
[20] W. Quan, W. Quan, B. Chen, B. Chen, F. Shu, and F. Shu, "Publish or impoverish: An investigation of the monetary reward system of science in China (1999-2016)," *Aslib J. Inf. Manag.*, vol. 69, no. 5, pp. 486–502, 2017.
[21] P. O. Larsen and M. Von Ins, "The rate of growth in scientific publication and the decline in coverage provided by science citation index," *Scientometrics*, vol. 84, no. 3, pp. 575–603, 2010.
[22] *Archived Lists*. Accessed: Jan. 2018. [Online]. Available: https://clarivate.com/hcr/researchers-list/archived-lists/
[23] P. Jump, "Manipulating citation rankings? Analysis looks at how some universities benefit from secondary academic affiliations," *Inside Higher Edu.*, accessed: Jan. 2018. [Online]. Available: https://www.insidehighered.com/news/2014/07/17/new-study-raises-questions-about-global-rankings-citations
[24] Elsevier. (Sep. 2017). *Scival*. [Online]. Available: https://www.elsevier.com/solutions/scival
[25] *Moscow State Institute of International Relations*. Accessed: Jan. 2018. [Online]. Available: https://en.wikipedia.org/wiki/Moscow_State_Institute_of_International_Relations
[26] *Astana*. Accessed: Jan. 2018. [Online]. Available: https://en.wikipedia.org/wiki/Astana
[27] A. Sarinzhipov, "Opportunities for faculty to influence academic matters at Kazakh National University and Eurasian National University," Ph.D. dissertation, Graduate School Edu., Univ. Pennsylvania, Philadelphia, PA, USA, 2013.
[28] (Sep. 2017). *Scimago Journal & Country Rank*. [Online]. Available: http://www.scimagojr.com/countryrank.php
[29] *Al-Farabi National University*. Accessed: Jan. 2018. [Online]. Available: http://www.kaznu.kz/en/
[30] *Tata Institute of Fundamental Research*. Accessed: Jan. 2018. [Online]. Available: http://www.tifr.res.in/vsrp/

MAXIME MUSSARD received the Ph.D. degree from the Norwegian Institute of Science and Technology, Trondheim, Norway, in 2013. His research interests are solar energy (both solar thermal, especially solar cooking, and photo-voltaic) and research ethics. He was at the INSA Lyon, France, as a part-time temporary faculty for one year before joining the Mechanical Engineering Department, Nazarbayev University, Astana, Kazakhstan, as an Assistant Professor in 2015. He published several papers about solar energy in top journals such as *Solar Energy*, *Applied Thermal Engineering*, and *Renewable and Sustainable Energy Reviews*. In addition to research, he is involved in teaching heat transfer, thermodynamics, fluid mechanics, and statistics and probabilities.

ALEX PAPPACHEN JAMES (SM'13) received the Ph.D. degree from the Griffith School of Engineering, Griffith University. He is currently the Chair of the Electrical Engineering Department, Nazarbayev University, and the Chair of the IEEE Kazakhstan Subsection. He is involved in brain-inspired circuits, memristor circuits, algorithms, and systems. He has sustained experience of managing industry and academic projects in board design, VLSI and pattern recognition algorithms, and semiconductor industry. He is a Senior Fellow of the Higher Education Academy, U.K. He is an Associate Editor of *Human-Centric Computing and Information Sciences*, the IEEE Access, the IEEE Transactions on Circuits and Systems 1, the IEEE Transactions on Emerging Topics in Computational Intelligence, and IET CPS (special issue) journals.