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A path for ranking success: what does the expanded indicator-set of international university rankings suggest?

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Abstract
Despite some theoretical and technical criticism, scholars largely acknowledge the influence of universities' ranking positions on the preferences of fund providers, academics and students, nationally and internationally. Considering their noticeable contribution to university rankings, prominent indicators can guide university leaders to develop better strategies by targeting common aspects of international ranking systems. The purpose of this research is therefore to specify the significant indicators and to examine their individual weight through an expanded indicator-set of international university rankings. The research benefited from the predictive approach of correlational research. The dataset was composed of universities' scores in the 2018 ARWU, THE, QS and URAP world university rankings and includes the scores of 224 universities. The data were re-organised following the expanded indicator-set previously formulated by the researcher. Regression analyses were then employed in two steps to explore significant predictors through the expanded indicator-set. The researcher also re-calculated the percentage values of seven combined indicators: *citation*, *income*, *internationalisation*, *prize*, *publication*, *reputation* and *ratios/degrees*. The findings showed that while all these indicators are statistically significant, the components of research reputation contribute 73.71% to universities' ranking scores. On the other hand, income is the only negative contributor with a weight of − 1.78%. The research also revealed that when comparing two scores based on re-calculated and assigned weights, only 19 universities occupy the same position among the 224 universities. Following these results, the researcher then discusses various policies and practices with the potential to expedite universities' ranking success. Considering the data reliability and longitudinal feasibility, several recommendations were also developed for further research on university ranking systems.

Keywords University league tables · International ranking indicators · Expanded indicator-set · Individual indicator weights · University ranking differentiation

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Introduction

Through institutional webpages, many universities highlight their places in the ranking tables to assert their higher-achieving performance. University leaders also frequently refer to the ranking achievements of their institutions to impress fund providers and attract the attention of academics and students, nationally and internationally. Therefore, university managers largely follow these ranking schemes to develop organisational policies and practices to enhance the ranking success of their own institutions (Hazelkorn 2015; Heffernan and Heffernan 2018; Shin et al. 2011; Tapper and Filippakou 2009). While university ranking systems mainly use publication and citation rates as common metrics, most of them also include a variety of different indicators such as reputation scores, award winners, faculty-per-student ratios, postgraduate-to-undergraduate student rates, doctoral graduates, number of foreign staff and students, international research collaboration, or income components (through teaching, research and services to industry and business). On this point, to know which indicators significantly contribute to ranking success may be helpful in formulating potential strategies at universities to increase their position in ranking systems.

Since the first announcement of the Academic Ranking of World Universities (ARWU) in 2003, there has been a growing number of university ranking systems (Jajo and Harrison 2014). These systems naturally intensify world-class university discussion through international ranking outputs (Altbach and Salmi 2011). Hence, higher education policymakers in many countries have generated national policies to enhance the ranking of their universities; for example, World Class 1.0, 2010 and Double First Class (or World Class 2.0), 2017 in China (PREC Edu Services, n.d.), Excellence Initiative 1.0, 2005 and 2.0, 2012 in Germany (DFG n.d.), or Academic Excellence Project (or Project 5–100), 2013 in Russia (5top100 n.d.). Another example, from the researcher's home country, is the government-selected list of the 10 best universities in Turkey announced in 2017, as the result of a national "research university" policy to include extra financial support and human resource expansion to achieve better results in international rankings (YÖK 2017). Considering both the potential expansion of funds and the positive influence on institutional choices of successful researchers and students, university managers mostly give special attention to ranking indicators when drawing up their organisational development strategies (Hazelkorn 2015). However, the content of indictor-sets and the calculation of ranking scores have raised many theoretical and technical questions.

Researchers have argued that while selected metrics in most international rankings are very useful to measure a university's research productivity and academic reputation, these rankings do not fully reflect the level of teaching quality and social/economic impact of universities (Lim 2018; Shattock 2017; Shin et al. 2011). International rankings have also been criticised for excluding graduate employment rates as another important metric regarding training quality in universities (Çakır et al. 2015; Uslu 2017a). In addition to these theoretical aspects, researchers have highlighted some technical fallacies associated with international university rankings. For example, Bougnol and Dula (2015) examined several ranking systems in terms of the handling of the data, exposing mistakes of logic and interpretation issues and concluded that the rankings contained four 'pitfalls.' These are anti-isotonic attributes (positive weights do not guarantee positive score contribution), rewarding inefficiency (the same level inputs might create smaller or higher outcomes for different universities), co-linearity in the data (due to their conjoint features, some attributes can be removed during the recalculation of weights) and transparency-reproducibility (considering the recalculation possibility, researchers cannot access to indicator scores or indicator weights in many rankings). Soh (2017) summarised 'the seven deadly sins' of international university rankings as follows: spurious precision, weight discrepancies, assumed mutual compensation, indicator redundancy, inter-system discrepancy, negligence of indicator scores and lastly inconsistency between changes in ranking and

overall. In a previous study, however, Soh (2015) used the 2013 data of ARWU, Times Higher Education (THE) and Quacquarelli Symonds (QS) rankings to show how various indicator scores contributed to universities' overall scores.

Despite the possible multicollinearity between various ranking metrics, some researchers examined the indicator-sets of various rankings and their influence on ranking achievements. Through their cross-national analysis of university ranking systems, Dill and Soo (2005, pp. 500–502) theoretically combined the performance indicators under four dimensions: (i) input (faculty, students, financial resources and facilities), (ii) process (teaching), (iii) output (satisfaction, graduation, value-added, learning progress, employment) and (iv) reputation. Similarly, Hendel and Stolz (2008, p. 180) compared the ranking systems in Europe and defined four categories, namely, input (beginning characteristics students, faculty and staff, financial resources, program design and amenities), throughput (program/course proceedings, organisation and management, student support system and teaching quality), output (career prospects, reputation, outcome measurements (e.g. degree awarded, completion rate, student satisfaction) and value added) and research (e.g. grants per faculty, international publications, citations per publication, patents per faculty). Furthermore, using ARWU, THE and QS metrics as latent variables, Jajo and Harrison (2014) statistically examined ranking achievements and found the beta coefficients[1] regarding the achievement data to be $\beta = .662$ for ARWU, $\beta = .220$ for QS and $\beta = .188$ for THE; in addition to $\beta = .159–.230$ for ARWU metrics, $\beta = .184–.384$ for QS metrics and $\beta = .090–.414$ for THE metrics. In another study, Luque-Martínez and Faraoni (2019, p. 10) clustered universities using indicator scores in ARWU, National Taiwan University Ranking (NTU), QS, THE and URAP rankings and associated indicators under seven university categories: (1) internationalised, (2) connected to industry, good reputation, (3) female students, (4) minor quality research, (5) global leaders, (6) low scientific production, quality and reputation and (7) intermediate majority. The researcher also examined the increase and decrease rates of universities' ranking positions through the expanded indicator-set of ARWU, QS, THE and URAP systems (see details in Methodology) and found that reputation and citation scores caused the highest increase/decrease in universities' ranking positions, by comparing how the increase/decrease rates originated according to publications, prizes, ratios/degrees, internationalisation and income scores (Uslu 2018a).

While some of the researchers mentioned above outline the theoretical and technical shortcomings of international rankings, they largely accept the impact of ranking systems on the international composition of the higher education sector. Others have focused on the metric schemes of these international rankings to explore the value of each indicator for universities' ranking success. The researcher has also shown what indicators expedite higher ratings in various international university rankings. However, none of the studies in the reviewed literature provides clarification about the contribution of each indicator within a combination of various ranking systems. Considering the influence of international rankings on institutional and even national higher education policies, on the other hand, statistically prominent indicators and their individual values can guide higher education policymakers and university managers towards developing better strategies targeting common aspects of international ranking systems. Accordingly, the purpose of this research is to identify the most significant indicators and to examine their individual weight by means of an expanded indicator-set of international university rankings. With this aim, the research questions are

[1] In predictive analyses, beta coefficient (β) indicates the individual contribution of the independent variable to the dependent variable. Here, for example, β = 662 for ARWU means a 1-point increase in ARWU brought a .662-point increase in the combination of ARWU, QS and THE.

1. Which indicators (and their sub-components) are statistically significant within the expanded indicator-set?
2. What is the individual weight of each significant indicator (and its sub-components) eliminating multicollinear connections within the expanded indicator-set?
3. How do universities' ranking positions differ comparing the overall scores of re-calculated individual weights with the total score of assigned weights within the expanded indicator-set?

Conceptual framework

Focusing on international ranking systems alone does not provide sufficient information to outline the organisational structure of high-ranked universities. However, one of the major approaches "to define a world-class university (WCU) is to identify the common features of the current top-ranking universities to provide some insights into the institutionalization of a WCU" (Shin 2013, p. 19). This apparent connection between global rankings and WCU definition will enrich the theoretical perspective to picturise the general characteristics of high-ranked universities (see Fig. 1). In this respect, a well-known study by Salmi (2009, p. 32) presents the essential requirements to establish a WCU, as follows (see Fig. 1): concentration of talent (students, teaching staff, researchers, internationalisation), Abundant resources (public budget resources, endowment revenues, tuition fees, research grants) and Favourable governance (supportive regulatory framework, autonomy, academic freedom, leadership team, strategic vision, culture of excellence). While Salmi (2009, p. 32) identified the major outcomes of WCUs in the general form of graduates, research outputs and technology transfer, Alden and Lin (2004) generated a long list of key characteristics of WCUs. Their list can be easily categorised in terms

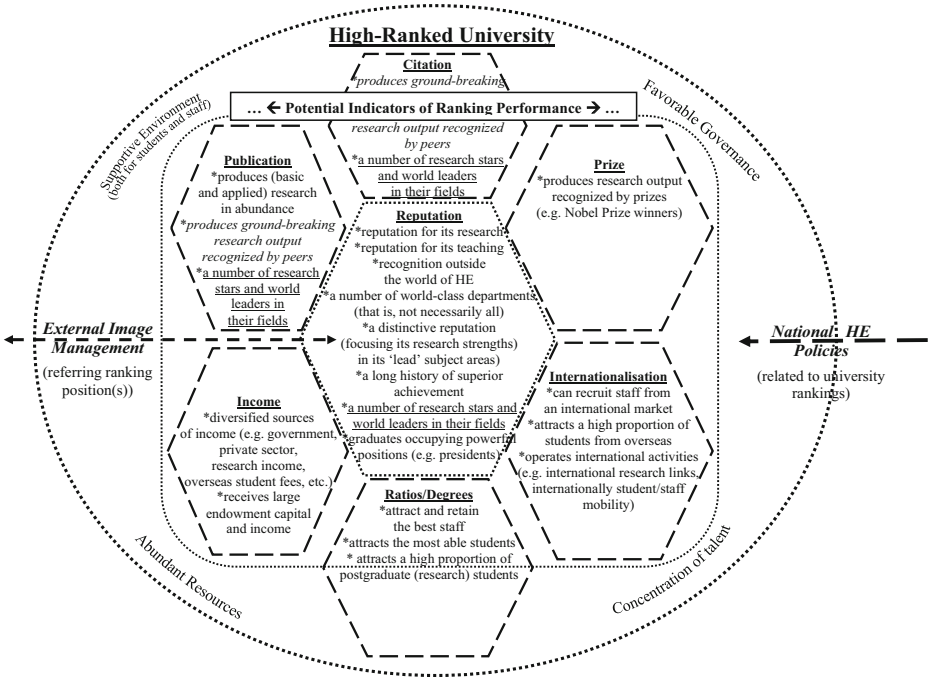

Fig. 1 General characteristics of high-ranked universities (based on Alden and Lin 2004; Hazelkorn 2015; Liu et al. 2019; Salmi 2009; Shin 2013)

of potential indicators of universities' ranking performance; namely, citation, income, internationalisation, prize, publication, ratios/degrees and reputation (see Fig. 1).

Additionally, Alden and Lin (2004) added 'supportive (research and educational) environment' as another important component to empower both the students' learning experience and the academic productivity of staff by establishing a high-quality campus and facilities in high-ranked universities. Further, through excellence initiatives, Liu et al. (2019, p. 10) recently argued for the role of national higher education policies (targeting better ranking positions) to support the financial and staffing aspects of universities in their countries. Lastly, while showing institutional actions regarding global rankings, Hazelkorn (2015, p. 209) indicated the re-contribution of marketing strategies that highlight their ranking position, thus adding to their reputation. All in all, the combination of these theoretical components illustrated in Fig. 1 provides a good basis to analyse the values of common indicators of university rankings and to discuss institutional strategies operated by universities to improve their ranking position.

Methodology

This research was designed as a correlational research. In the correlational research design, researchers assess the relation(s) between variables (e.g. views, opinions, attitudes, terms, phenomena, scores, points) by the explanatory or predictive approach through quantitative analysis (Ary et al. 2006; Tekbıyık 2014). In line with this definition, the data were firstly collected from various international university rankings, and then regression analyses were performed to explore the predictive relations between universities' ranking performance and the combination of indicators in the selected rankings.

Expanded indicator-set

The dataset includes universities' ranking scores re-calculated using the expanded indicator-set of international university rankings. The researcher followed here the expanded indicator-set of ARWU, QS, THE and URAP systems in his previous study (Uslu 2018a). He selected these ranking systems because of the availability of (full) indicator scores as well as their assigned weights (as percentage values). This expansion process fully complies with the potential ranking indicators outlined in the conceptual framework (see Fig. 1). While the conceptual framework provides well-established theoretical bases to discuss the analysis results, the expanded indicator-set also offers a comprehensive perspective to statistically examine each indicator.

Although the researcher took their similarities into consideration when re-grouping the indicators of ARWU, QS, THE and URAP, the richness of this expanded set comes from differences between the indicators of selected rankings. For example, ARWU and URAP benefit from the Web of Science (WOS) database to determine the publication and citation scores of universities, while QS and THE use the outputs of SCOPUS database. To enhance the comprehensiveness of the reputation category, the expanded set combines four different parts from QS and THE reputation surveys, as follows: QS-Academic Reputation, QS-Employer Reputation, THE-Research Reputation and THE-Teaching Reputation. Similarly, under the ratios/degrees category, this research expanded the ranking indicators through students-per-staff rates and doctoral degree ratios (against bachelor degrees and the number of academic personnel in universities) in the QS and THE rankings. In terms of internationalisation, QS and THE contribute to the expanded set by including international

student and staff ratios, while THE and URAP enrich the set with international collaboration scores. Further, ARWU and THE add two unique criteria to the expanded indicator-set; namely, ARWU-Prize (awarded to staff or alumni) and THE-Income (from teaching/research/industry-based work). All in all, the researcher formed the expanded indicator-set including seven indicator groups, five derived from various rankings while remaining two based on one, but different ranking systems (see Table 1).

Dataset

In this research, the dataset was prepared by entering the score separately for each indicator in each of these selected ranking systems onto Excel during the first half of 2018. Despite 959 universities being featured in QS World University Rankings 2018, more than one indicator scores were missing for most of the universities in the list; leaving 225 universities which had individual scores for all indicators within ARWU, QS, THE and URAP rankings in this dataset. While ARWU and URAP in 2018 provided a full-score for each indicator, a couple of universities in THE rankings had a missing indicator score that could be easily extracted by decreasing other indicator scores from the full-scores. Although QS rankings only provided an overall score for the first 400 universities (from all around the world), many of these top universities had one or more missing indicator scores. Overall, there is no clear pattern on missing indicator scores in the QS 2018 Rankings, despite relatively more absent indicator figures related to the international faculty and student ratios in Asian universities.

Further, ARWU announced their 2018 ranking results on August 15, 2018 (ARWU 2018a), while QS, THE and URAP had previously released their 2018 results. Therefore, the researcher updated the dataset adding ARWU 2018 ranking scores on Excel to ensure the inclusion of 2018 scores from all four selected ranking systems. Finally, by eliminating one more university because of its exclusion from ARWU 2018 rankings, the Excel sheet included ranking outputs (with all indicator scores) for 224 universities via their 2018 scores in ARWU, QS, THE and URAP world university rankings. The country distribution of these 224 universities largely reflects the continental distribution of universities in the selected rankings, as follows: 28 from Asia (including universities from 7 countries), 107 from Europe (including universities from 14 countries), 2 from the Middle East (1 Israeli and 1 Saudi Arabian), 63 from North America (12 Canadian and 51 American), 23 from Oceania (19 Australian and 4 New Zealander) and 1 from South Africa (see Table 3 in the Appendix).

Data analysis

After completing the dataset of 224 universities' ranking scores, the researcher firstly transferred the data from the Excel sheet to SPSS programme interface. To calculate the individual value of each criterion in the expanded indicator-set, he preferred to use standardised Beta (β) coefficients of regression analysis. While un-standardised β coefficients include collinear relations between variables, a standardised β coefficient shows the contribution of the related variable excluding its contribution through other variables on the dependent variable (Hair, Black, Babin and Anderson, 2010). Unlike the general assumption in regression-based analyses as in predicting a dependent variable through one or more independent variables (e.g. $X = \text{constant} + a\beta_a + b\beta_b + c\beta_c + \ldots$), this research adopted the approach of predicting a dependent variable via its sub-components (e.g. $X = \text{constant} + Xa\beta_{Xa} + Xb\beta_{Xb} + Xc\beta_{Xc} + \ldots$). This naturally means obtaining the determinant coefficient as one ($R^2 = 1$), the sign of full

Table 1 Score criteria in expanded indicator-set with sources

Combined indicators	Sources of indicators			
	ARWU*	QS	THE	URAP
Citation	Highly cited researchers in 21 broad subject categories (HiCi) 22.22%	Citation per faculty 20%	Citations 30%	Citation 21%; citation impact total 15%
Publication	Papers published in Nature and Science (N&S) 22.22%; Papers indexed in Science Citation Index-expanded and Social Science Citation Index (PUB) 22.22%	–	Research productivity 6%	Article 21%; total document: 10%; article impact total 18%
Reputation	–	Academic reputation 40%; employer reputation 10%	Teaching reputation 15%; research reputation 18%	–
Prize	Alumni of an institution winning Nobel Prizes and Fields Medals (alumni) 11.11%; staff of an institution winning Nobel Prizes and Fields Medals (award) 22.22%	–	–	–
Ratios/degrees	–	Faculty/student ratio 20%	Staff/student ratio 4.5%; doctorate/bachelor's ratio 2.25%; doctorates awarded/academic staff ratio 6%	–
Internationalization	–	International faculty ratio 5%; International student ratio 5%	Proportion of international students 2.5%; proportion of international staff 2.5%; international collaboration 2.5%	International collaboration 15%
Income	–	–	Teaching income 2.25%; research income 6%; industry income 2.5%	–

*The indicator of PCP (Per Capita Performance of an Institution) with 10% weight in ARWU was distributed to five other indicators, which are the basis of PCP, in line with their percentage weights

Source: Uslu (2018a), based on ARWU (2018b); QS (2018); THE (2018a); URAP (2018)

prediction/explanation on the dependent variable, while exploring the contribution of sub-components through their standardised β coefficients.[2]

As the starting point, the researcher calculated the weighted sub-criteria scores for each university in the dataset (e.g. the university's score in the HiCi of ARWU × 22.22%) using the Compute Variable function of SPSS 21 Software. Following the calculation of the weighted score for each sub-criterion, he also calculated the combined scores for seven indicators in the expanded set. The researcher then employed Multiple Regression Analysis on the dataset to explore the predictive relations between universities' ranking performance and their indicator scores. Firstly, pre-tests were applied to ensure the availability of the dataset for the regression analysis (Hair et al. 2010), as following: (1) in terms of the sample size, the ranking scores of 224 universities are adequate for the regression analysis including seven independent variables (considering the general calculation approach as 50 + [8 × 7indicators] = 106). (2) The dependent variable and total ranking scores (and also scores of each indicator for further regression analyses) are normally distributed in accordance with Skewness-Kurtosis values between ± 2 (Skw = .950; Krt = .712–for seven indicators: Skw = −.117–1.399; Krt = −.969–2.144). 3) The multiple linear connections between research variables are at an acceptable level considering the Tolerance > .10 and VIF < 10 criteria of Collinearity Statistics (see Table 2). (4) According to the Durbin-Watson test (criterion of D-W ≈ 2), there is no autocorrelation between error ratios in the analysis (see Table 2).

Ensuring the necessary assumptions for regression analysis, the researcher employed the first multiple regression analysis by appointing universities' overall ranking scores as dependent (predicted) variables and the unweighted scores of seven indicators in the expanded set as independent (predictive) variables. During further regression analyses, he used the total score for each indicator as a dependent (predicted) variable and the unweighted scores of sub-criteria of the related indicator as independent (predictive) variables. For the regression analyses in the current research, the significance level was assigned as .05. In the last phase, the researcher calculated the percentage value of each indicator (and also for its sub-criteria) in the expanded set by benefiting from their standardised β coefficients.

Findings

The analyses and calculations were carried out sequentially as per the research questions. First, regression analysis was employed to explore the predictive relations between the seven indicators of the expanded set and the overall (weighted) ranking score through ARWU, QS, THE and URAP rankings. The results are summarised in Table 2.

As can be seen in Table 2,[3] each indicator score is the significant predictor for universities' ranking performance ($t = -2.831$–33.979; $p \leq .05$). While other scores had a different level of

[2] In the predictive analysis, the determinant coefficient (R^2) indicates the explanation ratio of dependent (predicted) variables by independent (predictive) variables. Then, $R^2 = 1$ means all predictor variables that together explain the whole constitution of the predicted variable. In this research, while the un-standardised beta (β) coefficient of each indicator shows its assigned value by the related ranking system (ARWU, QS, THE or URAP), the standardised β coefficient reveals the individual contribution of the related indicator (see previous example in Endnote-1 above).

[3] While the seven indicators together fully explain universities' ranking scores (according to $R^2 = .997$), standardised β values show "Ranking Score = .313*x*(publication) + .285*x*(reputation) + .274*x*(citation) + .150*x*(ratios/degrees) + .104*x*(prizes) + .078*x*(internationalisation)−.021*x*(income)". *t* and *p* values together also indicate valid test results for individual contribution of the related indicator at significance level (here .05)

Table 2 Regression analysis of the expanded indicator-set and universities' ranking score

Indicator	β	*t*	*p*	Collinearity	
				Tolerance[¥]	VIF[†]
Publication	.313	30.892	.000*	.127	7.860
Reputation	.285	33.537	.000*	.182	5.499
Citation	.274	33.979	.000*	.202	4.961
Ratios/degrees	.150	28.950	.000*	.486	2.057
Prize	.104	19.449	.000*	.462	2.164
Internationalisation	.078	18.739	.000*	.762	1.311
Income	− .021	− 2.831	.005*	.248	4.038
Model summary	$R = .999$; $R^2 = .997$; $F_{(7–216)} = 10{,}877.135$; $p = .000$*; D-W[∏] = 1.576				

*$p \leq .05$

[¥] Tolerance > .10

[†] VIF < 10

[∏] D-W ≈ 2

contribution (standardised β = .078–.313) to universities' ranking position, income (β = −.021) was the only predictor negatively influencing the overall ranking scores. The percentage values of each of the seven indicators[4] were calculated using their standardised β values and added to Fig. 2.

In the second-order analysis, each indicator within the expanded set was individually examined to observe the predictive relations between the indicator (weighted) score and its sub-indicators (through their unweighted scores). The results of the indicator level-regression analysis were added to Fig. 1 in order to see the complete path of universities' ranking performance. For each indicator in the expanded set, the percentage values of its sub-indicators[5] were also calculated via their standardised β values (see Fig. 2).

According to Fig. 2, publication (26.46%) has the highest contribution to universities' ranking score while reputation the second (24.09%) and citation the third (23.16%). Remaining four indicators altogether 26.28% contribute to universities' ranking performance. Taking the 400% total of ARWU, QS, THE and URAP rankings into account, the percentage values of seven indicators were compared with a quarter of their assigned percentages. This comparison shows that ratios/degrees made the highest percentage gain with a 4.49% increas[6] against the highest percentage lost (4.47%) in the income scores. Further, THE-staff/student ratio and THE-doctorate/bachelor's ratio were not a significant predictor for ratios/degrees while THE-proportion of international students and THE-proportion of the international staff were not a significant predictor for internationalisation. In addition, Q-academic reputation had the highest value with 12.79% whereas THE-research income had the lowest (with − 1.02%). Among sub-indicators, however, QS-faculty/student ratio showed the greatest increase with a 4.26% gain[7], and demonstrated the greatest decrease (2.52%) on THE-research income.

Lastly, the total ranking scores were calculated using the assigned percentages of indicators in ARWU, QS, THE and URAP ranking systems (see Table 1). Universities' ranking scores were also calculated using the percentages of indicators (through their standardised β coefficients) within the expanded set. The results of these two rankings, which were based on the assigned and re-calculated

[4] e.g. Percentage value of publication = [.313/(.313 + .285 + .274 + .150 + .104 + .078–.021)] × 100 = 26.46%.

[5] e.g. Percentage value of ARWU-Publication = [.266 / (.266 + .265 + .231 + .172 + .099 + .045)] × 26.46 = 6.53%.

[6] e.g. 32.75% in total 400% of ARWU, QS, THE and URAP (see Table 1); 32.75%/4 = 8.19%; 12.68–8.19% = 4.49%

[7] e.g. 20% in total 400% of ARWU, QS, THE and URAP (see Table 1); 20%/4 = 5%; 9.26–5.00% = 4.26%

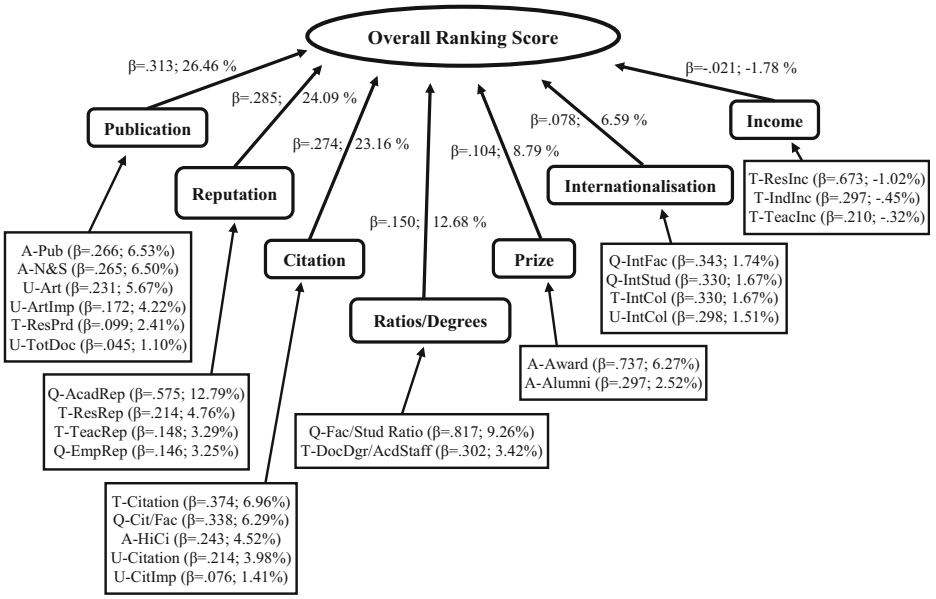

Fig. 2 Path for ranking success using the expanded indicator-set

percentages, were then compared (see Appendix). According to this comparison, only 19 universities occupy the same position in both rankings of the expanded indicator-set, assigned and recalculated, while 205 universities had different ranks. Whereas the highest decrease for universities in the calculated rankings was 21 places against the assigned rankings of the expanded indicator-set, the maximum increase was 22 (see Appendix). It can be seen in the Appendix, except for one (from China), that 19 universities having the same position are from Anglo-Saxon countries, as follows: seven from the United States of America, four from the United Kingdom, two from Australia, one from Canada, one from Germany, one from New Zealand, one from Norway and one from Switzerland. With greater or lesser transposition (from 1 place to 22 places), the remaining 91.52% of the 224 universities show a highly divergent picture compared to their original positions in the selected four ranking systems (see Appendix).

Discussion and conclusion

This research re-ranked universities taking into account the individual contributions of score criteria within the expanded indicator-set. The expanded indicator-set includes the ranking metrics used by ARWU, THE, QS and URAP for their 2018 world university rankings. Although it appears there are no mysterious results, the research revealed a common path for ranking success through the contribution of each significant indicator in the expanded set.

Indeed, the results strongly confirmed the comment of one of the researcher's former interviewees, as follows: "For the rankings, the most important thing is research reputation [a combination of research productivity, research impact and academic reputation]. The second most important thing is, again, research reputation" (Uslu 2017a). For example, this research showed that publications are the primary source of universities' ranking performance, and, with a value of 26.46%, they are 1.6% more influential than the assigned percentage average (24.86%) for the selected four ranking systems. This

result is expected when we consider the strong ties between publication volume and the second and third highest contributor indicators, reputation and citation. It is important to remember here that the selected ranking systems use the output of WOS or SCOPUS databases to calculate universities' publication score. Although other factors increasing a university's reputation in global academia are discussed below, publication volume in these international databases is obviously the main feed line for their research reputation (Bowman and Bastedo 2011; Collins and Park 2016; Hazelkorn 2015). In addition to attracting more attention in global academia, the publications indexed in prestigious databases also gain more citations from other researchers. The reason is simply a high correlation between citation rates and the impact factors of the related journals (Jarwal et al. 2009; Shin et al. 2011). Accordingly, WOS and SCOPUS, as the two most prestigious databases, include academic journals with a high impact factor; the publications in these journals then assist in increasing universities' citation score, with 23.16% value in the expanded indicator-set.

Unlike accessible (and reviewable) data provided by WOS or SCOPUS on publication and citation, reputation surveys employed by two ranking systems (QS and THE) lead us to pose questions in terms of valid and reliable representation of the global academic community. Further, these reputation surveys can be criticised on the basis of their approach, purpose and calculations. Although Spence (2019) suggested preferring 'judgement' rather than 'metrics' for measurement of performance in higher education, the 'judgement' of reputation in international university rankings does not comply with the main approach of measurement, as in "the measurement of outcomes and their correlation with… 'input'… aims to provide an evidence-base for [higher] educational practice" (Biesta 2009, p. 34). In the end, as Shin and Toutkoushian (2011) clearly stated, "reputation measures have limitations in reflecting the quality of teaching and research" (p. 5) because of their validity, reliability and measurability shortages. However, among the sub-indicators within the expanded set, academic reputation (from QS with 12.79% value, against 3.25% for employer reputation) is still the highest contributor to universities' ranking performance. As the researcher's previous study (Uslu 2018a) revealed, universities' reputation scores are also the main indicator designating their increase or decrease in the selected rankings. This increase/decrease pattern based on the reputation scores of universities is the main factor behind the inconsistency between the two rankings, prepared based on assigned and calculated values of indicators in the expanded set (see Appendix). The greatest gap is generally between universities' calculated rankings and positions in QS where half of the overall score comes from their reputation survey (see Appendix). Accordingly, this gap might be the reason for a slight increase of non-western universities compared to their western competitors in the calculated rankings through the expanded indicator-set (see Appendix).

In every case, considering the 73.71% value of research reputation components (research productivity, research impact, academic reputation) together for international rankings, university managers should firstly develop various strategies to enhance their publication and citation rates in globally prestigious databases. Here, the components of the conceptual framework in the present study provide insights into the importance of having talented staff, large resources, high-quality facilities and influential management practices. Therefore, there are two basic approaches for university managers to increase their research reputation. As Hazelkorn (2015) argued, one is "recruit[ing]/head-hunt[ing] international high-achieving/HiCi scholars" (p. 209) if universities have the resources to attract them. The other approach is raising their own star by academic support mechanisms and well-established institutional norms (Uslu 2017b); as in examples from all over the world, largely integrating tenure/promotion and reward/incentive schemes (Cadez et al. 2017; Macfarlane 2007), writing support mechanisms (McGrail et al. 2006) and incorporating publication support (especially for open access options) in project budgets (Gargouri et al. 2010). When we consider the tippy-top of international rankings; however, it is a very challenging task for universities

to force their way into the forefront, even if they could achieve higher scores from the publication and citation categories. The top places are almost completely occupied by older universities (including two that were founded in medieval times), and they seem to have a self-feeding loop on 'the road to academic excellence', using the advantages of their long-standing historical prestige to obtain larger resources and attract productive researchers and better students (Altbach and Salmi 2011; Uslu 2017b). Therefore, despite their smaller contribution, other indicators gain importance for universities to further raise their position in international rankings.

While the number of 'students' and 'doctoral degrees' per faculty, as the sub-indicators of the ratios/degrees category, contributes 12.68% to universities' ranking scores, award-winning academics and alumni can provide an 8.79% increase in ranking scores. Commenting the QS Methodology, as follows: "The [Faculty/Student Ratio criterion] recognizes that a high number of faculty members per student will reduce the teaching burden on each individual academic" (QS 2018)), the student/faculty ratio is obviously the sign of larger research time for academics. Doctoral degree completions per faculty also indicates the significant contribution that doctoral students provide to university publication records, especially through peer-reviewed articles and chapters in which PhD researchers and their advisors collaborated (Horta and Santos 2016). The *award* indicator only includes highly prestigious scientific prizes and medals such as the Nobel Prize and Fields Medal (ARWU 2018b); therefore, the award-winning staff and alumni naturally promote the reputation of their institutions within both global academia and the international community. The internationalisation indicator also adds 6.59% value to the universities' ranking score via its contribution to institutional reputation, as well as research productivity. If we take the similar contribution of internationalisation components (from 1.51 to 1.74%) into account, it appears to be equally important for universities to expand their reputation wider by having more international staff and students (Chapleo 2010; Delgado-Marquez et al. 2013) and to enrich their research portfolio with international collaborations (Abramo et al. 2011; Kwiek 2015). Therefore, university managers can prioritise the appointment of highly qualified foreign researchers and institute scholarship programmes targeting international students to empower their global visibility and international publication profile.

In these two respects of the conceptual framework (see Fig. 1), all around the world governments have provided remarkable support for universities within the framework of various internationalisation policies and programmes. Examples include the Laureate Fellowships in Australia, Research Chairs in Canada, Thousand Talents Professorship in China, DAAD Scholarships in Germany, UKRI Research Training Funds in the UK and Türkiye Scholarships in Turkey. This is in addition to the initiatives of multinational funding bodies such as Marie Skłodowska-Curie Actions exchange, co-funding and fellowship programmes of the European Commission. Further, as two other common strategies (Uslu 2017b; Wang and Shapira 2011), university managers may establish (at least, a limited number of) institutional advanced grants and/or starting funds for project applications to national and international research councils in order to support assertive research endeavours, if their potential for internationally scientific awards is taken into consideration (Tatsioni et al. 2010). Here, external image management, another component of the conceptual framework, would play an important role for universities to beat the drum for various achievements from local to global level. Therefore, to enhance the reputation of their institutions both in the academic community and in the public eye (Uslu 2018b), university managers can benefit from different media channels to publicise success stories such as ranking performance, entrepreneurial and social projects, as well as award winners and the international composition of their institutions.

Unlike others, the income indicator exerts a negative influence (− 1.78% against 2.69% average assigned value) on universities' ranking scores. This is truly not a well-advised finding by reason of the data source(s) used for income metrics. Whereas THE (as the only ranking

including income components) largely uses accessible data sources such as academic databases for publication and citation or official statistics for faculty/student and degree completion ratios and even applied data weighting (by subject and/or continent) in their reputation surveys (e.g. THE methodological explanation (THE 2018b)), it would seem they do not have any option other than self-reported data by individual universities in order to collect institutional income figures. This obviously creates a data-reliability problem for the income component within university rankings. For example, the researcher looked at two example institutions in his home country. While the top 10 universities in the general rankings did not achieve 90 points, these two universities were uppermost in industry income rankings with over 90 points (THE 2019a), despite their position at around 20 in the Entrepreneurial and Innovative University Index of Turkey (TÜBİTAK 2019), against 64 points of industry income in THE rankings for the champion in the national list. Apart from theoretical criticism (Harvey 2008; Shin et al. 2011), this sort of reliability concern, as well as other technical issues such as weight discrepancies and co-linearity in the data (Bougnol and Dula 2015; Soh 2017) within 'research reputation' rankings, possibly led to alternative ranking mechanisms gaining more importance in global academia and also visibility in the international community.

However, similar problems are also seen within the scope for alternative ranking outputs. As the latest product of THE rankings, they prepared the University Impact Rankings 2019, following the 11 Sustainable Development Goals (SDG) published by the United Nations (THE 2019b). While "Research metrics [we]re derived from data supplied by Elsevier" for this new ranking, they announced that "Institutions provide[d] and sign[ed] off their institutional data for use in the rankings" for various SDG (e.g. good health and well-being, gender equality or climate action) so as to again bring up the question of reliability of institutions' self-reported data (THE 2019b). Another alternative ranking list, Reuters Top 100: The World's Most Innovative Universities, counted 10 various metrics (with equal weights) (Reuters 2018a), but released only three scores, namely, Total Patents Filed, Patents Granted (as two direct metrics) and Commercial Impact (Reuters 2018b). When the 100 universities are re-ranked using these three scores and their assigned percentage values, the positions of nearly all the universities are very different in the list[8]. This is a clear sign of the 'Transparency and Reproducibility' problem (Bougnol and Dula 2015), which is due to giving insufficient explanation of the metrical score methodology and using a vague statistical procedure to produce the overall scores.

All in all, via the comprehensive structure of the expanded indicator-set, this research identified a common path for ranking success in universities. In doing so, the analysis assessed the percentage value of each indicator (and also its sub-components) by eliminating multicollinearity between the ranking indicators. However, by collecting data from the four selected international rankings, this research naturally has limitations in terms of data-reliability and reproducibility. Therefore, the reliability of data source(s) is potentially a research topic of its own, considering each of the ranking indicators. Additionally, further research might focus on the re-examination of selected ranking cases or different expanded university ranking schemes. Researchers may also employ the same analysis to long-term data of the selected four rankings (starting from 2010, with the first announcement of URAP

[8] e.g. ([Number of Patent applications/100] × 10) + ([Granted Patent Percentage/100] × 10) + ([Commercial Impact Score/100] × 80)

Re-calculation by the above formula resulted in different ranks for 95 universities, and the top university lost ground to sixth position.

Appendix

Table 3 Comparison of universities by expanded indicator-set ranking and position in selected rankings

University	Country	Calculated E-IS		Assigned E-IS		Positions in the Selected Rankings			
		Score	Rank	Rank	Score	ARWU	QS	THE	URAP
Harvard	USA	100.20	1	1	395.40	1	3	6	1
Stanford	USA	92.76	2	2	363.06	2	2	3	5
MIT	USA	90.36	3	3	354.99	4	1	5	7
Cambridge	GBR	90.07	4	4	353.04	3	5	2	9
Oxford	GBR	87.86	5	5	346.90	6	6	1	3
Columbia	USA	82.33	6	8	320.55	7	18	14	15
UCLondon	GBR	82.09	7	7	320.83	16	7	16	6
Chicago	USA	82.05	8	9	318.32	9	9	9	21
UC, Berkeley	USA	81.63	9	6	327.68	5	27	18	11
CalTech	USA	81.00	10	11	314.15	11	4	4	55
Johns Hopkins	USA	80.15	11	10	316.10	17	17	13	8
Yale	USA	79.94	12	12	311.17	12	16	12	19
Princeton	USA	78.99	13	15	308.62	8	13	7	79
Pennsylvania	USA	78.91	14	14	309.30	18	19	10	14
ICLondon	GBR	78.70	15	17	307.75	26	8	8	16
Cornell	USA	77.98	16	18	305.80	14	14	19	20
Toronto	CAN	77.20	17	16	308.15	21	30	23	2
UC, LA	USA	77.00	18	13	309.34	10	32	15	13
ETH Zurich	CHE	76.61	19	20	300.41	19	10	11	34
Michigan	USA	76.49	20	19	300.98	23	22	21	10
Duke	USA	74.07	21	22	291.88	22	20	17	26
UC, San D.	USA	72.53	22	23	290.28	15	36	30	18
Northwestern	USA	72.47	23	24	283.44	24	28	20	39
Washington	USA	72.11	24	21	293.75	13	56	25	12
Edinburgh	GBR	71.35	25	26	277.92	30	23	27	46
NU Singapore	SGP	71.02	26	27	277.82	76	15	22	27
Tsinghua	CHN	70.97	27	25	279.17	38	25	29	23
KCLondon	GBR	68.76	28	33	266.25	46	24	35	52
New York	USA	68.72	29	31	266.52	27	47	26	59

Table 3 (continued)

University	Country	Calculated E-IS		Assigned E-IS		Positions in the Selected Rankings			
		Score	Rank	Rank	Score	ARWU	QS	THE	URAP
EPF Lausanne	CHE	68.06	30	35	262.19	57	12	37	84
Manchester	GBR	68.03	31	34	264.63	31	33	50	44
Wisconsin-Md	USA	67.92	32	32	266.35	25	50	41	31
Peking	CHN	67.86	33	29	270.53	45	35	28	25
Melbourne	AUS	67.33	34	28	271.67	34	39	31	29
Nanyang TU	SGP	67.28	35	37	260.15	82	11	48	51
British Colum.	CAN	67.20	36	30	269.34	36	46	33	22
McGill	CAN	66.69	37	36	261.22	61	31	40	35
Aus Nat Uni	AUS	64.39	38	42	250.94	65	21	45	99
Copenhagen	DNK	64.03	39	45	250.00	29	68	97	17
U Hong Kong	HKG	63.91	40	48	247.10	109	26	38	103
WU StLouis	USA	63.71	41	43	250.43	20	87	46	49
UNC C. Hill	USA	63.53	42	44	250.08	28	71	51	37
Heidelberg	DEU	63.09	43	46	249.91	39	63	43	43
Seoul Nat.	KOR	62.94	44	51	245.44	91	34	66	38
Queensland	AUS	62.92	45	39	252.33	49	42	57	36
Sydney	AUS	62.63	46	38	252.74	62	45	54	24
TU Munich	DEU	62.58	47	49	247.08	40	59	39	73
UI U.Chmp.	USA	62.24	48	40	252.21	33	62	36	62
Carnegie M.	USA	62.17	49	50	246.68	73	43	24	150
Bristol	GBR	62.06	50	53	239.04	64	40	67	83
LMU Mun.	DEU	62.00	51	41	251.99	44	61	34	47
Fudan	CHN	60.61	52	60	234.17	95	37	103	58
Brown	USA	60.61	53	61	233.84	94	48	47	116
UPMCurie	FRA	60.16	54	47	247.50	32	111	110	4
UNSW	AUS	59.79	55	55	237.76	86	41	75	53
Zurich	CHE	59.56	56	65	229.80	47	67	118	56
Ohio State	USA	59.43	57	58	235.26	66	77	62	33
Amsterdam	NLD	59.31	58	56	236.68	105	53	52	57
HKong UST	HKG	59.00	59	64	229.98	169	29	42	170
Georgia IT	USA	58.95	60	54	239.04	74	64	32	94

Table 3 (continued)

University	Country	Calculated E-IS		Assigned E-IS		Positions in the Selected Rankings			
		Score	Rank	Rank	Score	ARWU	QS	THE	URAP
KU Leuven	BEL	58.72	61	52	242.69	71	65	44	40
Monash	AUS	58.38	62	57	236.13	72	55	71	48
Boston	USA	58.30	63	63	230.01	60	72	63	72
Helsinki	FIN	57.68	64	69	226.43	51	90	79	63
Utrecht	NLD	57.51	65	59	234.63	41	97	60	41
SJTong U	CHN	57.21	66	66	228.63	83	57	155	28
Warwick	GBR	56.89	67	77	221.22	87	52	80	140
MarylandCP	USA	56.51	68	67	226.87	42	109	61	61
UC, Davis	USA	56.45	69	62	230.15	75	104	49	45
Glasgow	GBR	56.01	70	81	219.43	120	60	70	102
Purdue	USA	56.01	71	70	226.16	59	93	53	89
Zhejiang	CHN	55.97	72	68	226.62	55	78	149	30
Delft UT	NLD	55.86	73	72	223.02	134	49	55	139
Lund	SWE	55.82	74	75	222.16	103	69	82	68
Groningen	NLD	55.81	75	74	222.38	58	101	73	66
KAIST	KOR	55.71	76	84	216.96	151	38	84	158
Pittsburgh	USA	55.69	77	78	220.92	63	120	88	32
CityU HnKg	HKG	55.66	78	88	213.60	147	44	105	149
Geneva	CHE	55.39	79	79	220.37	50	86	115	82
Uppsala	SWE	55.08	80	76	221.66	54	100	76	77
Rice	USA	54.82	81	89	212.83	69	80	77	168
Southern Cal	USA	54.73	82	73	222.99	48	112	58	80
Leiden	NLD	54.68	83	71	223.31	68	98	59	75
Sheffield	GBR	54.64	84	87	213.70	104	74	91	105
Ghent	BEL	54.58	85	80	219.85	52	107	94	54
Alberta	CAN	54.38	86	85	216.01	110	82	106	67
Nottingham	GBR	54.35	87	91	212.71	84	75	131	96
Osaka	JPN	54.16	88	93	211.78	88	58	177	92
U WesternAus	AUS	53.96	89	83	217.25	80	83	98	85
Birmingham	GBR	53.90	90	90	212.79	102	76	124	90
Aarhus	DNK	53.84	91	82	218.23	56	105	96	60

Table 3 (continued)

University	Country	Calculated E-IS		Assigned E-IS		Positions in the Selected Rankings			
		Score	Rank	Rank	Score	ARWU	QS	THE	URAP
Southampton	GBR	53.69	92	94	211.63	108	91	111	86
Col Boulder	USA	53.09	93	92	212.21	35	154	89	88
Tokyo IT	JPN	53.03	94	109	201.14	122	51	188	156
Emory	USA	52.85	95	100	207.36	106	125	87	70
Uni Oslo	NOR	52.69	96	95	210.56	53	121	128	74
Wageningen	NLD	52.66	97	98	208.69	123	106	56	121
Vanderbilt	USA	52.63	98	97	208.85	43	170	92	64
McMaster	CAN	52.55	99	96	210.50	70	118	68	100
Ec Polytech	FRA	52.49	100	113	199.63	211	54	102	202
Leeds	GBR	52.49	101	99	208.09	98	89	121	113
EU Rotterdam	NLD	51.95	102	86	214.08	77	127	64	78
Durham	GBR	51.94	103	104	205.68	142	70	86	157
Sungkyunkwan	KOR	51.85	104	105	204.47	132	96	99	98
TU Denmark	DNK	51.80	105	111	200.51	118	103	136	108
Montreal	CAN	51.42	106	102	206.37	114	110	95	81
TCB, Dublin	IRL	51.02	107	108	202.98	124	79	104	161
Florida	USA	50.52	108	103	205.97	67	151	126	50
Michigan State	USA	50.45	109	101	206.83	97	126	74	91
Adelaide	AUS	50.44	110	106	203.71	112	99	117	115
PUST	KOR	50.41	111	129	193.78	212	66	120	198
KTH RIT	SWE	50.28	112	124	196.23	154	88	144	138
Paris-SUD	FRA	50.21	113	110	200.65	37	188	151	69
QMULondon	GBR	50.00	114	118	197.63	126	108	108	133
Korea Uni	KOR	49.99	115	126	194.53	143	81	180	111
HK PolytechU	HKG	49.70	116	125	194.76	148	85	153	153
St Andrews	GBR	49.63	117	135	191.53	194	84	125	189
Auckland	NZL	49.59	118	115	199.01	139	73	157	132
Cardiff	GBR	49.57	119	123	196.37	99	116	139	123
Basel	CHE	49.57	120	107	203.30	85	128	85	112
HU Jerusalem	ISR	49.49	121	127	193.91	79	123	160	127
EKUTubingen	DEU	49.35	122	122	196.47	129	139	83	104

Table 3 (continued)

University	Country	Calculated E-IS		Assigned E-IS		Positions in the Selected Rankings			
		Score	Rank	Rank	Score	ARWU	QS	THE	URAP
Lausanne	CHE	49.27	123	131	193.17	111	124	134	141
Gottingen	DEU	49.19	124	120	197.17	81	152	101	122
Karlsruhe IT	DEU	49.06	125	117	197.67	156	95	116	124
Yonsei	KOR	48.89	126	134	191.61	178	94	174	95
Eindh. UT	NLD	48.86	127	137	190.35	197	92	123	183
Bern	CHE	48.74	128	112	200.21	93	140	93	101
Radboud	NLD	48.50	129	119	197.62	101	164	107	71
Barcelona	ESP	48.35	130	116	197.94	115	133	178	42
Virginia	USA	48.34	131	128	193.79	119	145	100	109
ALU Freib.	DEU	48.16	132	114	199.62	100	144	72	118
Rochester	USA	48.15	133	140	188.03	116	156	135	126
Liverpool	GBR	47.94	134	133	191.62	90	146	148	110
RW Aachen	DEU	47.47	135	121	197.05	166	119	69	120
DartmouthC	USA	47.15	136	141	186.30	167	142	78	176
Exeter	GBR	46.97	137	138	190.15	121	136	114	154
York	GBR	46.79	138	143	184.70	187	114	119	177
VU Amster.	NLD	46.78	139	130	193.78	92	175	141	65
UC Louvain	BEL	46.60	140	136	191.15	128	131	113	142
Arizona State	USA	46.53	141	132	191.87	89	168	112	119
TU Berlin	DEU	46.38	142	139	188.10	176	122	81	191
Newcastle	GBR	46.35	143	146	184.45	146	138	146	137
Lancaster	GBR	45.84	144	148	182.08	188	115	133	195
Malaya	MYS	45.76	145	160	175.17	184	102	209	148
Aalto	FIN	45.66	146	151	180.01	192	117	156	163
Aberdeen	GBR	45.31	147	152	179.85	155	135	154	175
ENS, Lyon	FRA	45.18	148	166	173.56	205	134	152	213
Waterloo	CAN	44.98	149	145	184.50	138	130	162	134
Rutg. SUNJ	USA	44.77	150	142	185.51	78	205	143	87
Chalmers UT	SWE	44.71	151	156	176.97	182	113	179	186
Maastricht	NLD	44.58	152	144	184.50	173	161	90	128
UA Barcel.	ESP	44.42	153	147	183.03	185	160	129	97

Table 3 (continued)

University	Country	Calculated E-IS		Assigned E-IS		Positions in the Selected Rankings			
		Score	Rank	Rank	Score	ARWU	QS	THE	URAP
UL Bruxelles	BEL	44.00	154	150	180.34	125	165	147	151
Hamburg	DEU	43.97	155	149	180.41	127	178	163	93
Calgary	CAN	43.86	156	153	179.57	131	174	164	106
Otago	NZL	43.53	157	157	176.26	195	129	168	166
Antwerp	BEL	43.41	158	170	171.67	177	171	161	152
Cape Town	ZAF	43.22	159	154	177.35	181	159	142	147
Notre Dame	USA	43.21	160	158	175.70	153	173	132	179
Hanyang	KOR	42.92	161	179	168.85	164	132	207	155
VU Brussel	*BEL*	*42.91*	**162**	**184**	*165.86*	*179*	*155*	*197*	*171*
Sussex	GBR	42.86	163	161	174.59	141	181	130	185
Georgetown	USA	42.68	164	165	173.67	162	182	109	200
UC Dublin	IRL	42.65	165	168	172.48	186	141	175	180
UI, Chicago	USA	42.59	166	167	172.99	149	167	183	130
Gothenburg	SWE	42.50	167	163	173.99	113	204	159	125
Reading	GBR	42.28	168	173	170.29	171	158	172	203
West. Ontario	CAN	42.27	169	159	175.44	152	169	167	136
Leicester	GBR	42.10	170	171	170.92	174	186	138	164
QU Belfast	GBR	42.09	171	177	169.31	200	162	165	165
WWU Munster	DEU	41.85	172	164	173.97	117	213	145	129
Twente	NLD	41.78	173	175	170.06	216	150	150	188
NUST	NOR	41.68	174	174	170.12	96	193	193	145
TU Dresden	DEU	41.54	175	155	177.04	130	203	137	107
UT Sydney	AUS	41.51	176	172	170.40	193	148	169	197
Bath	GBR	41.47	177	183	165.96	214	137	186	204
UA Madrid	ESP	41.11	178	187	164.55	172	157	210	143
Pol. de Milano	ITA	41.08	179	180	168.52	158	143	198	173
Cologne	DEU	40.93	180	169	171.81	133	217	127	135
Sun Yat-Sen	CHN	40.68	181	176	169.52	107	215	202	76
NCSU	USA	40.59	182	181	166.83	135	196	190	131
FAUNurnberg	*DEU*	*40.27*	**183**	**162**	*174.01*	*140*	*209*	*140*	*114*
Ottawa	CAN	40.21	184	178	169.20	137	210	176	117

Table 3 (continued)

University	Country	Calculated E-IS		Assigned E-IS		Positions in the Selected Rankings			
		Score	Rank	Rank	Score	ARWU	QS	THE	URAP
QU Kingston	CAN	40.01	185	185	165.45	168	179	184	160
Pompeu Fabra	ESP	39.72	186	182	166.00	175	212	122	194
Wollongong	AUS	39.60	187	190	163.10	160	184	189	184
Macquarie	AUS	39.50	188	189	163.40	157	187	185	182
Queensland UT	AUS	39.37	189	186	165.26	165	191	170	178
Vienna UT	AUT	39.36	190	191	162.79	199	153	199	192
NUI Galway	IRL	39.21	191	200	155.82	213	189	181	216
UniNewcastle	AUS	39.08	192	193	160.26	189	180	194	187
Paris Dauphine	FRA	38.99	193	188	164.08	204	220	65	223
Innsbruck	AUT	38.73	194	196	157.19	144	207	195	201
Turku	FIN	38.47	195	205	152.81	183	200	205	172
Curtin	AUS	38.44	196	195	157.64	136	195	212	159
K. Fahd UPM	SAU	38.38	197	213	146.95	206	147	220	222
Stuttgart	DEU	38.38	198	192	160.95	180	194	171	206
Northeastern	USA	38.03	199	194	158.49	163	218	158	193
Linkoping	SWE	37.76	200	208	150.71	190	208	208	167
Surrey	GBR	37.37	201	203	154.33	202	197	191	208
Canterbury	NZL	37.33	202	204	152.88	209	172	206	219
Deakin	AUS	37.33	203	198	156.20	145	211	200	174
G.Washington	USA	37.29	204	197	156.21	170	219	173	181
Aalborg	DNK	37.16	205	199	156.09	159	224	166	190
NCTU	TWN	36.89	206	210	149.23	217	166	216	199
Laval	CAN	36.82	207	201	155.30	161	223	187	146
VU Welling	NZL	36.80	208	207	151.63	201	176	213	221
Virg. PISU	USA	36.74	209	202	154.66	150	222	196	144
Griffith	AUS	36.46	210	206	152.30	203	216	192	169
Loughboro.	GBR	36.31	211	212	147.64	222	185	201	218
NCKU	TWN	36.30	212	211	149.03	196	177	219	162
Centralesup.	FRA	36.29	213	220	139.73	224	149	215	224
USthernAus	AUS	36.14	214	209	150.70	219	202	182	212
RMIT	AUS	35.74	215	215	146.85	198	190	217	205

Table 3 (continued)

University	Country	Calculated E-IS		Assigned E-IS		Positions in the Selected Rankings			
		Score	Rank	Rank	Score	ARWU	QS	THE	URAP
Waseda	JPN	35.45	216	217	142.16	208	163	221	211
UC Cork	IRL	35.35	217	214	146.88	207	206	203	209
UP Catalun.	ESP	34.71	218	221	139.24	220	199	218	196
Heriot-Watt	GBR	34.62	219	216	142.47	215	214	204	220
Strathclyde	GBR	34.51	220	219	141.47	218	201	214	207
UP Malaysia	MYS	33.61	221	222	132.39	221	183	223	210
UT Malaysia	MYS	33.52	222	224	129.73	223	192	222	215
La Trobe	AUS	33.45	223	218	141.85	191	221	211	214
US Malaysia	MYS	32.24	224	223	129.80	210	198	224	217

Notes: ISO 3166 Three-Digit Codes were used to indicate countries. *Calculated E-IS* shows total scores based on percentages (of indicators) through β outputs in the research. *Assigned E-IS* shows total scores based on percentages (of indicators) assigned by the related ranking system, ARWU, QS, THE, or URAP. Here, the outputs in Uslu's (2018a) study were updated using ARWU indicator scores and rankings in 2018.

rankings, the newest ranking scheme in the study) in order to examine the longitudinal feasibility of findings in this research.

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