Acta Scientific COMPUTER SCIENCES

Volume 4 Issue 3 March 2022

Literature Review

An Ameliorated Methodology for the Design and Development of Indexing the Educational Institutes

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Received: December 17, 2021

Published: February 25, 2022

Abstract

The methodologies for ranking the educational Institutes adopted by world class indexing organizations are based on some criterion values that are supposed to index the quality of education in the institute. In reality, all these criteria are not independent to each other as few criteria may be independent and paves the scope for their enhancement without their real contribution to the quality of education, some dependent on the flow from other criterion values, and some others criterion values are not in entirety the contribution from the education quality of the institute. These issues have been resolved in our proposed methodology. The next issue is that the provision of weightages to the criteria without the authentication of the dimensional equipollency between environmental, intermediary and receivable criterion cluster values. The other issue is the way to compute criterion appropriateness in determining the quality of education. In this paper, an attempt is made to compute the appropriate quality index through the criterion values flow to the receivable criteria. In au-courant process, the quality index is manually measured through the maximum flow of the criterion values to the receivable criteria. The intermediate criterion capacities depend on the source criterion holistic capacities. The receivable criteria receive maximum up their receipt of the flow and the remnant value may not contribute to the quality of the Institute. Ford-Fulkerson and others have developed manual iterative methodologies to compute the maximum flow from source criteria to receivable criteria. This methodology works for limited number of criteria that too with recursive procedure. In ranking, the criteria are large in numbers with their hierarchies. Therefore, in this paper an attempt is made to develop an automated methodology to compute ranks of institutes resolving all the extant shortfalls.

CCS Concepts

- Computing Methodologies. Development of new algorithm for indexing, based on the criterion values.

Keywords: Criterion Value; Capacity; Flow Graph; Flow Matrix; Environmental Criteria; Intermediate Criteria; Receivable Criteria; Maximum Flow; Quality Index

Introduction

- **Vision:** To design and develop an automated methodology to determine exact rank (education quality index) ofan Institute.
- **Mission:** To develop the methodologyfor rank of Institute, with flows usingflow matrix with different criterion capacity vertices.

Objectives

- To determine the rank through the criterion flows limited by their capacityvalues.
- To use backward depth first search algorithm for traversal of flow matrixcapacity elements.
- To assign the capacity to each criterion,based on the regulating authorities andthrough equipollency of cluster of intermediary and receivable criteria detect the deficiency if any.
- To appraise the appropriateness of theadopted criterion capacities for the ranking purpose.
- To segregate inherent criterion valuesof the immediate passed out studentsfrom quality criteria adopted in determining the rank of Educational Institute.

Motivation

There are number of issues in the extant ranking systems. In the au-courant methodology, the rank of the institute is determined by the criterion values for criteria set by the individual indexing organization. These criteria are of three types viz., environmental criteria that provide momentum for the quality of the institute, the intermediate criteria that receives flow from environmental criteria and provide values flow to receivable criteria and the receivable criteria receive flow from intermediate criteria and decide the criterion quality values. The criteria and weightages are fixed by the regulating authority and receivable criteria each of whose value determines the quality of institute education and personal effort / intelligence or other factors of the individual stakeholders. The computation of intermediate criterion values also depends on receiving flows from environmental criteria. The computation of criterion values of receivable criteria depends on both the receiving flows of intermediate criteria and psychomotor knowledge access process of passed out students. Thus, the extant method of computing sole criterion capacities cannot solely determine quality of Institute's education. The weightages (values) for criteria or sub criteria set by the indexing organization have not been universally applicable. They should depend additionally on the efficacious intelligence (psychomotor knowledge acquisition process) of the receivable criteria. Moreover, the indexing organization might not have precisely defined the flow dependencies and might not have maintained the dimensional equipollency of cluster weightages between the three clusters of criteria and /or the participating Institute might have exemplified the receivable criterion values. These have to be resolved and in addition, the manual process of computing the value based on the appropriate criterion values cannot correctly determine the education quality as evidenced by average salary of outgone students. The next issue is the computation. The success of manual iterative computation depends on human expertness and the number of participating criteria. There is a need to automate the process of computation. In addition, the weightages, that determine the criterion capacities should be designed in such a way that there should be a proper equipollency between inter category capacities so as to receive ultimate capacitive flows of connected environmental criteria. Moreover, the indexing organizations have psychomotor knowledge acquisition process of the passed-out students.

The automatic computation requires two factors viz., the representation of weighted criteria / sub criteria and the methodology to compute. For flow dependent criterion weights, flow matrix may serve for representation for the understanding of both human and machine. The methodology requires some traversal algorithm based on the order of travelogue. In the absence of flow dependency between individual criteria, the matrix may be a row vector of three cluster criterion categories.

Literature Survey

Quaquarelli Symonds (QS) and Times Higher Education (THE) are the world defacto standard indexing organizations for computing the rank of applicant educational institutes. In India, the National Institutional Ranking Framework (NIRF), is the standard indexing organization. These organizations determine ranking of institutes in general and also subject wise. IN QS, the general computation of ranking of institutes is based on Academic reputation (40%) based on academic survey of expert opinions (94000), Employer reputation (10%) based on employer survey (45000), Faculty-student ratio (20%) comprises number of faculty members per student, citation per faculty (20%) comprises total number of citations of faculty members of the institute over a period of five years divided by number of faculty members and international faculty ratio (5%) and international student ratio (5%) which gives international brand for the institute facilitating best practices and beliefs [1].

The 'THE' [2] determines the rank of institutions in five areas. In teaching (the learning environment) criterion (30%), comprises sub criteria reputation survey (15%), faculty-student ratio (4.5%), Doctorates-to-Bachelors degree (2.25%), Doctorate awarded to academic staff 6% and institutional income (2.25%). The academic survey taken annually (21000) underpins how the institution nurtures the next generation academics. Research (volume, income and reputation) (30%) criterion comprises reputation survey (18%), research, income (6%), research productivity (6%). The next criterion is Citations (research influence (30%). This is computed from citations of papers of the faculty in Elseavier and scopus database. The criterion international outlook (staff, student and research) 7.5% comprises proportion if of international staff (2.5%), proportion of international students (2.25%) and international collaboration (2.5%). The last criterion industry income (knowledge transfer) 2.5% [2].

Similarly, the National Institutional Ranking Framework (NIRF) [3] is the indexing organization for Indian Universities/institutes' ranking. This organization ranks the institutes in five criteria viz., Teaching, Learning and Resources (30%) criteria comprises sub criteria as student strength 6%, Faculty student ratio 9% Faculty qualification and experience 6% and financial resource utilization

9%. Research and Professional Practice (30%) comprises sub criteria Weighted average of quality publication per faculty (9%), citation per publication (12%), patents filed, granted and published (4.5%) and earning from knowledge transfer (4.5%), Graduation Outcomes (20%) comprises percentage of graduate students on campus placement 8%, percentage of students passed over three years 3%, minimum maximum and median salary of outgone student 4%, number of students admitted to top universities 3% and number of Ph. D. student graduated 2%. Outreach and Inclusivity (10%) comprises number of students enrolled from other states 2.5%, other countries 0.5%, percentage of women faculty 1%, percentage of girl students 1% and representation of women in the governing council 0.5%, percentage of economically and socially challenged students 2.5%, facilities for physically challenged students 2% and Perception (10%) [3]. These have been determined by the experts in the education field. There may be some flow dependencies between these criteria.

In these criteria, academic reputation, faculty-student ratio, international staff, economically and socially challenged students, girl students, women staff, and lady representation in Governing council are source criteria and not solely determines the quality of education. The values may be considered as of infinite capacity as their flow to intermediate criteria are the sole some determining factors.

Citation per faculty, research income, student strength, financial resource utilization, quality publication, patents filed, and campus placement, are flow dependent on source criteria and hence are intermediate flow dependent criteria. Their capacity maybe determined from regulating organization norms. These may be the maximum values and actual flow in from source criteria are the deciding factors. The flow out from these may not be greater than flow in.

Employer reputation, International faculty and students, reputation survey, doctorates- to Bachelors' degree, doctorates awarded to academic staff, income, from knowledge transfer, percentage of students passed, and median salary may not solely determine the quality as they may have positive or negative inherent characters. These are the sink criteria. Their achieved values are only capacities. The contribution of the institute is only the receipt of the flow from intermediate criteria.

This can be represented in the form of flow graph with vertices as criteria or sub criteria with their capacity as their weightages defined above. The flows from source and intermediate criteria are the sole factors and are represented by 'edges'. If the flow dependencies are not directly determinable, the graph will be a three vertices simple flow graph. Ford-Fulkerson et al have developed a manual technique to determine the maximum flow [4] from the flow dependent graph with vertices having certain preassigned capacities and edges have the actual flow for an instance of data. This is an iterative process and may not precisely determine the flow when number of criteria increases. Moreover, there does not exists maintenance of equipollency of capacities between the afore said three clusters of criteria. Therefore, there is quintessence of developing automated methodology to determine the appropriate flow of quality parameters. This needs the representation in machine understanding form. In this paper, an attempt is made to represent the graph in the flow matrix form of the order $((\boldsymbol{n} - (\boldsymbol{l} + \boldsymbol{m}))\ \boldsymbol{X}\ \boldsymbol{n})$ where $\boldsymbol{n}$ is the number of criteria and '$\boldsymbol{l}$' is the number of environmental and '$\boldsymbol{m}$ ' is the number of intermediary criteria. Now, the issue is the computation of maximum flow. The well- known depth first search (DFS) algorithm [5] may help with appropriate modification. The algorithm keeps on 'VISITing the progressive next node till the path exists. Then it PROCESSes in the backward direction, till the node have alternative progressive path/ paths. In this present scenario, the environmental criteria do not possess (as per our version) sole quality enhancing values, it has been assumed to have full criterion values wherever there exists path from intermediary or environmental criteria. This creates the problem in using direct DFS 'process' way. Therefore, in this paper, the backward DFS is developed and implemented. Here, processing is considered if there is path from receivable to environmental criteria.

Taxonomy

Flow graph G (V, E): The vertices V ∈ $[\mathbf{1}, (\boldsymbol{l} + \boldsymbol{m})]$ for contains capacities of the criteria and $(\boldsymbol{n} - (\boldsymbol{l} + \boldsymbol{m}))$ receivable criteria contain their achieved values.

Flow Matrix $((\boldsymbol{l} + \boldsymbol{m})\ \boldsymbol{X}\ (\boldsymbol{n} - (\boldsymbol{l} + \boldsymbol{m})))$ contains the capacities of vertices in diagonal elements of the submatrix $((\boldsymbol{l} + \boldsymbol{m})\ \boldsymbol{X}\ (\boldsymbol{l} + \boldsymbol{m}))$. The receivable criteria contain the achieved values comprising contribution of quality education and on their own in all the rows of their columns where there are flows to them. We have created dimensional equipollency of weights and ultimately the extent of the flow is considered for computation.

Environmental Criteria are the capacities provided by external agencies, all values of which may not participate in the quality of education. So, we have considered the flow as infinity.

Intermediate criteria are the values generated by environmental criteria. Therefore, provision is made for establishing the dimensional equipollencybetween the intermediary and receivable criterion clusters.

Receivable criteria are the achieved values by the flows they receive and on their own.

Proposed methodology

Let $S1, S2, \ldots$ be the l environmental criteria, m be the number of intermediary criteria $V1, V2, \ldots$ and $T1, T2, \ldots$ are the $(n-(l+m))$ be the receiver criteria.

Procedure:

1. Organize $((l+m)\ X\ (n-(l+m))$ matrix.
$M_{ii} :=$ environmental & intermediary criterion values for $i \in [1,(l+m)]$ and
$M_{ij} :=$ receiver criterion values for $\{i,j \mid i \in [1,(l+m)], j \in [(l+m+1),n]$ and
$(i,j) \in$ flow from (i,i) to (i,j);
$Q := 0; Q_j := 0; Q_{ij} := 0.$
2. for $j := (i+m+1)$ to m do
3. for $i := 1$ to $(l+m)$ do
4. If $M_{ij} = 0$ then $i := i+1$ until $M_{ij} \neq 0$
5. $Temp(ij) := M_{ij}; Temp(ii) := M_{ii};$
6. for $k := 1$ to $(l+m)$,: $M_{ki} = 0, k := k+1$ until $M_{ki} \neq 0$, then $Temp(ki) := M_{ki};$
7. If $k \in [1,l]$ then $Temp(kk) := M_{kk}; i := k$
8. Repeat steps 5 to 7 until $k \in [1,l]$
9. $Q_{ij} := Q_{ij} + \min \{M_{ij}, M_{ii}, M_{ki}, M_{kk}, M_{ki}, M_{kk}, \ldots\}$ until $k[1,l];$
10. $M_{ij} := M_{ij} - Q_{ij}, M_{ii} := M_{ii} - Q_{ij}, M_{kj} := M_{kj} - Q_{ij}, M_{kk} := M_{kk} - Q_{ij}, M_{ki} := M_{ki} - Q_{ij}, M_{kk} := M_{kk} - Q_{ij};$
11. Repeat steps 5 to 10 until $M_{ij} = 0$ or $\min \{M_{ij}, M_{ii}, M_{ki}, M_{kk}, M_{ki}, M_{kk}, \ldots\} = 0;$
12. $i := i+1; Q_j := Q_j + Q_{ij}; Q_{ij} := 0;$
13. end(for i);
14. $Q := Q + Q_j; j := j+1; Q_j := 0;$ end ;
15. Q is quality value of institute.

Case Study

Since there is no flow to any of the intermediate vertex from Source, the remnant values of T1, T2 and T3 are notfrom the contribution of the quality education. The total flow from resourcecriteria is 120.

Conclusion

In au-courant scenario, the quality of education is determined by the sum of the criterion values of criteria achieved by appropriate organization, set by the indexing organization. In reality some criteria can be procured without their real contribution in the quality of education. In actual practice, the flow from these criteria only contributes towards quality of education. The intermediate criteria may have some capacities that are the sum of the values flowed to them. The maximum contribution from all these are their contributions in the achieved values of received criteria. The received criterion values may not completely from the quality of education i.e. the holistic flow from intermediate criteria. Part of receiving criterion values may be from the individual psychomotor knowledge accessing process of the individual. In deciding the quality

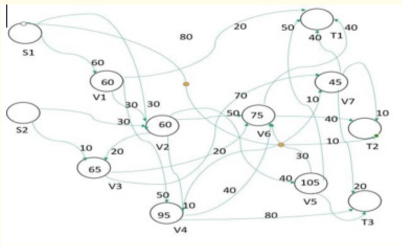

Figure 1: Graph depicting three types of criteria and the flows between them.

	S1	S2	V1	V2	V3	V4	V5	V6	V7	T1	T2	T3
S1	∞	C	60	30	00	00	00	00	00	00	10	00
S2	C	∞	00	30	10	00	00	00	00	00	00	00
V1	00	00	60	30	00	50	00	00	00	00	00	00
V2	00	00	00	60	20	10	40	50	00	00	00	00
V3	00	00	00	00	65	00	00	20	70	00	00	00
V4	00	00	00	00	00	95	00	40	10	00	00	80
V5	00	00	00	00	00	00	105	30	00	50	00	00
V6	00	00	00	00	00	00	00	75	00	40	40	00
V7	00	00	00	00	00	00	00	00	45	40	10	20

Figure 2

The flow from S1-V2-V5-T1 is 30

	S1	S2	V1	V2	V3	V4	V5	V6	V7	T1	T2	T3
S1	∞	C	60	00	00	00	00	0	C	00	10	00
S2	C	∞	00	30	10	00	00	0	C	00	00	00
V1	00	00	60	30	00	50	00	00	00	00	00	00
V2	00	00	00	30	20	10	10	50	00	00	00	00
V3	00	00	00	00	65	00	00	20	70	00	00	00
V4	00	00	00	00	00	95	00	40	10	00	00	80
V5	00	00	00	00	00	00	75	30	00	20	00	00
V6	00	00	00	00	00	00	00	75	00	40	40	00
V7	00	00	00	00	00	00	00	00	45	40	10	20

Figure 3

The flow from S2-V2-V5-T1 is 10

	S1	S2	V1	V2	V3	V4	V5	V6	V7	T1	T2	T3
S1	∞	C	60	00	00	00	00	00	00	00	10	00
S2	C	∞	00	20	10	00	00	00	00	00	00	00
V1	00	00	60	30	00	50	00	00	00	00	00	00
V2	00	00	00	20	20	10	00	50	00	00	00	00
V3	00	00	00	00	65	00	00	20	70	00	00	00
V4	00	00	00	00	00	95	00	40	10	00	00	80
V5	00	00	00	00	00	00	65	30	00	10	00	00
V6	00	00	00	00	00	00	00	75	00	40	40	00
V7	00	00	00	00	00	00	00	00	45	40	10	20

Figure 4

The flow from S2-V2-V6-T1 is 20

	S1	S2	V1	V2	V3	V4	V5	V6	V7	T1	T2	T3
S1	∞	C	60	00	00	00	00	00	00	00	10	00
S2	C	∞	00	00	10	00	00	00	00	00	00	00
V1	00	00	60	30	00	50	00	00	00	00	00	00
V2	00	00	00	00	20	10	00	30	00	00	00	00
V3	00	00	00	00	65	00	00	20	70	00	00	00
V4	00	00	00	00	00	95	00	40	10	00	00	80
V5	00	00	00	00	00	00	65	30	00	10	00	00
V6	00	00	00	00	00	00	00	55	20	20	40	00
V7	00	00	00	00	00	00	00	00	45	40	10	20

Figure 5

The flow from S1-V3-V6-T1 is 10

	S1	S2	V1	V2	V3	V4	V5	V6	V7	T1	T2	T3
S1	∞	C	50	00	00	00	00	00	00	00	10	00
S2	C	∞	00	00	00	00	00	00	00	00	00	00
V1	00	00	50	30	00	40	00	00	00	00	00	00
V2	00	00	00	00	20	10	00	30	00	00	00	00
V3	00	00	00	00	55	00	00	10	70	00	00	00
V4	00	00	00	00	00	95	00	40	10	00	00	80
V5	00	00	00	00	00	00	65	30	00	10	00	00
V6	00	00	00	00	00	00	00	45	20	10	40	00
V7	00	00	00	00	00	00	00	00	45	40	10	20

Figure 6

The flow from S1-V1-V4-V6-T1 is 10

	S1	S2	V1	V2	V3	V4	V5	V6	V7	T1	T2	T3
S1	∞	C	40	00	00	00	00	00	00	00	10	00
S2	C	∞	00	00	00	00	00	00	00	00	00	00
V1	00	00	40	30	00	30	00	00	00	00	00	00
V2	00	00	00	00	20	10	00	30	00	00	00	00
V3	00	00	00	00	55	00	00	10	70	00	00	00
V4	00	00	00	00	00	85	00	30	10	00	00	80
V5	00	00	00	00	00	00	65	30	00	10	00	00
V6	00	00	00	00	00	00	00	35	20	00	40	00
V7	00	00	00	00	00	00	00	00	45	40	10	20

Figure 7

The flow from S1-V1-V4-V6-V7-T1 is 10

	S1	S2	V1	V2	V3	V4	V5	V6	V7	T1	T2	T3
S1	∞	C	20	00	00	00	00	00	00	00	10	00
S2	C	∞	00	00	00	00	00	00	00	00	00	00
V1	00	00	20	30	00	10	00	00	00	00	00	00
V2	00	00	00	00	20	10	00	30	00	00	00	00
V3	00	00	00	00	55	00	00	10	70	00	00	00
V4	00	00	00	00	00	65	00	10	10	00	00	80
V5	00	00	00	00	00	00	65	30	00	10	00	00
V6	00	00	00	00	00	00	00	15	00	00	20	00
V7	00	00	00	00	00	00	00	00	25	20	10	20

Figure 8

The flow is from S1-V1-V4-V6-T2 is 20

	S1	S2	V1	V2	V3	V4	V5	V6	V7	T1	T2	T3
S1	∞	C	10	00	00	00	00	00	00	00	10	00
S2	C	∞	00	00	00	00	00	00	00	00	00	00
V1	00	00	10	30	00	00	00	00	00	00	00	00
V2	00	00	00	00	20	00	00	10	00	00	00	00
V3	00	00	00	00	55	00	00	10	70	00	00	00
V4	00	00	00	00	00	65	00	10	10	00	00	80
V5	00	00	00	00	00	00	65	30	00	10	00	00
V6	00	00	00	00	00	00	00	05	00	00	10	00
V7	00	00	00	00	00	00	00	00	25	20	10	20

Figure 9

There is flow from s1-V1-V4-V7-T1 is 10

	S1	S2	V1	V2	V3	V4	V5	V6	V7	T1	T2	T3
S1	∞	C	20	00	00	00	00	00	00	00	10	00
S2	C	∞	00	00	00	00	00	00	00	00	00	00
V1	00	00	20	30	00	00	00	00	00	00	00	00
V2	00	00	00	00	~~10~~ 10	00	20	00	00	00	00	
V3	00	00	00	00	55	00	00	10	70	00	00	00
V4	00	00	00	00	00	45	00	00	00	00	00	80
V5	00	00	00	00	00	00	65	30	00	00	00	00
V6	00	00	00	00	00	00	00	05	00	00	20	00
V7	00	00	00	00	00	00	00	00	25	10	10	20

Figure 10

of education, these externally achieved values may be discarded. Hitherto this has not been considered by the world class indexing organizations. Another issue is manual computation representing the entire scenario by flow graph serves only for limited number of criteria that too iteratively. There is quintessence need to automate this process as criteria are on the increase. In this paper, the flow graph is represented in machine understanding flow matrix form. The complicated issue of filtering values responsible only for quality of education is solved with modified DFS through backward visiting and forward processing. This, may contribute to the indexing organizations to decide the genuine factors in quality of 'institutes' education and assigning ranks to them. This will also streamline the weightage given to each criterion through dimensional equipollence. As a byproduct, the developed methodology, identifies the correctness and completeness of the criterion weightages set by the indexing organization and detects the fraudulent data entered by the competing institute. The purpose of this paper is limited to determine the educational rank of the Institute and hence the inherent characters of passed-out students which are outside the scope of quality of education, have not been categorically weighed.

Acknowledgments

The author acknowledges the constant support and encouragements provided by his mentor and guide Dr. D. B. Phatak of IIT Bombay.

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