Bellarmine University Office of Institutional Research & Effectiveness
Benchmarking Methods for 2019-2020 KPI Project

1. **The task.** Select a pool of potential peer/aspirant institutions based on relevant factors.

   a. Factors must align with the dynamic and periodic institutional KPIs under development by request of the Cabinet (per the August 13, 2019 retreat and AGB article)

   b. Peers will consist of credibly similar "nearest neighbor" institutions on a range of factors

   c. Aspirants will consist of institutions "within striking distance" of Bellarmine based on a majority of these factors (the ones that are "positive" constructs, i.e. where increasing similarity over time signals Bellarmine's growth or improvement of quality)

   d. Thus, attainable targets for dynamic and periodic KPIs will emerge from the aspirant list

   e. Ongoing "health check" approach to KPIs will arise from cyclical benchmarking activity of Bellarmine's progress versus both peer and aspirant institutions

2. **Data sources.** Sources were selected based on four criteria: (a) must contain current and/or very recent raw data; (b) must be reliable; (c) must be repeatedly accessible for future analysis; and (d) variables must align closely to Bellarmine's dynamic and periodic variables.

   a. NCES/IPEDS meets all criteria for the majority of quantitative and characteristic data

   b. NSSE for potential engagement data? Not ideal: Bellarmine's 2018 response rate was fairly low; BU only participates every three years; not all possible benchmark institutions participate; benchmark institutions' data are only shared with Bellarmine in the aggregate

   c. AAUP or CUPA for faculty salaries? Relevant only if we knew all factors influencing salary ranges relative to cost of living index, internal benchmarking goals, mission, etc.

   d. USNWR? Possible to download raw data for a nominal fee, but some institutions do not participate and there are reliability questions

   e. Automated peer/aspirant list generation tools? There are several:

      i. [Peer institution finder based on academic program mix](#) (pst.edu)

      ii. [Higher education benchmarking tool based on IPEDS data](#) (shinyapps.io)

      iii. [Comparative analysis of higher education institutions based on IPEDS and Brookings Institute value-added measures](#) (rapidinsightonline.com)

      iv. [2019 IPEDS Data Feedback Report](#) (nces.ed.gov)

      v. [NACUBO Benchmarking Tool](#) (nacubo.org)

      vi. [National Higher Education Benchmarking Institute](#) (benchmarkinginstitute.org)

   These tools generally rely on limited factors, outdated data, and/or flimsy methods. We elected to produce this analysis in-house, ensuring future replicability and cost savings.

3. **Data collection.** Using NCES/IPEDS "Use the Data" tool:

    a. Compare Institutions By Groups: EZ Group

    b. Initial filter criteria (number of remaining institutions in parenthesis)

        i. Title IV participating (6,361)

        ii. U.S. only (6,215)

    c. Additional filter criteria based on special characteristics:

        i. Bureau of Economic Analysis (BEA) regions: excluded U.S. Service schools and Outlying Areas (6,214)

        ii. Sector: included Private, not-for-profit (1,586) and Public, four-year (765; total of 2,351)

        iii. Degree-granting status: Degree-granting (2,344)

        iv. Highest degree offered: DRS and DPP (430), DRS only (280), DPP only (296), DO (68), and Master's (733; total of 1,807)

        v. Institutional category: Degree-granting, primarily baccalaureate or above (1,509)

        vi. Carnegie Classification 2018 (Basic): Doctoral/High Research (129), DPU (130), Master's/Large (322), and Master's/Medium (172; total of 753)

        vii. Institution size category: 1,000-4,999 (330) and 5,000-9,999 (196; total of 526)

        viii. Has FTFT undergraduates: Yes (521)

        ix. All programs offered completely via distance education: No (521)

        x. Minus Bellarmine (520)

4. **Variable selection.** Downloaded list of 520+1 institutions by Unit ID for reference. Explored available variables on the NCES website and compared against KPI dynamic and periodic list.

    a. Variables were organized into six domains. This approach creates a notional structure for tests of multicollinearity among variables as well as eventual hierarchical cluster analysis.

        i. Domain 1 – Institutional characteristics (five of the 11 categorical variables used in Step 3.c. had more than one option; these are denoted with an asterisk):

            1. BEA regions*

            2. Sector of institution*

            3. Institution size category*

            4. Highest degree offered*

            5. Carnegie Classification 2018

        a. Basic*

        b. Size and Setting *(used to determine the proportion of students living in campus housing)*

        c. Undergraduate Instructional Program *(used to determine the proportion of graduate presence/co-existence)*

        d. Undergraduate Profile *(used to determine selectivity)*

6. Religious affiliation

7. Intercollegiate basketball division (NCAA D-I, D-II, D-III, NAIA, etc.)

8. Institution offers dedicated services for military/veteran students

9. Institution offers state-approved initial certification/licensure of teachers

10. Total dormitory capacity per UG fall FTE

ii. Domain 2 – Admissions trends:

1. Admit yield *(five year average)*

2. Change in admit yield *(measured as % change over five years; since Bellarmine has had growth in this metric, we want to establish if there are other institutions who have experienced similar growth?)*

3. Number of applicants, total *(five year average)*

4. Percent of applicants admitted *(five year average)*

5. ACT English 25th percentile *(five year average)*

6. ACT English 75th percentile *(five year average)*

7. ACT Math 25th percentile *(five year average)*

8. ACT Math 75th percentile *(five year average)*

9. Percent of FTFT UG awarded federal grant aid *(five year average)*

10. Percent of UG students awarded federal student loans *(five year average)*

iii. Domain 3 – Faculty trends:

1. Average salary equated to 9-month contracts of full-time instructional staff, all ranks *(five year average)*

2. Instruction expenses per FTE (FASB) *(five year average)*

3. Salaries and wages for instruction as a percent of total expenses for instruction (FASB) *(three year average)*

4. Instructional FTE *(five year average)*

5. Student-to-faculty ratio *(five year average)*

6. Student-to-FT-faculty ratio (instructional FTE / unduplicated student FTE) *(five year average)*

7. Percent of full-time faculty holding terminal degrees (USNWR)

   iv. Domain 4 – Enrollment trends:

1. Fall FTE *(five year average)*

2. 12-month unduplicated UG FTE (reported if available, estimated if not) *(five year average)*

3. 12-month unduplicated GR FTE (reported if available, estimated if not) *(five year average)*

4. 12-month unduplicated DPP FTE (reported only) *(five year average)*

5. In-state UG residency percentage (state of residence where first-time UG student who is a recent high school graduate was first admitted, from residence and migration of FT freshman / fall UG FTE) *(five year average)*

6. URM %age of UG FTE

7. Change in URM UG proportion *(measured as % change over five years; since Bellarmine has had significant growth in this metric, are there other institutions who have experienced similar growth?)*

8. Percent of military/veterans per fall FTE

9. Percentage of classes enrolling fewer than 20 students (USNWR)

   v. Domain 5 – Financial trends:

1. Total price for in-district students living on-campus *(five year average)*

2. Average net price for students awarded grant or scholarship aid *(three year average)*

3. Net tuition revenue (NTR) per unduplicated FTE *(five year average)*

4. Change in NTR per FTE *(measured as % change over two years)*

5. Discount rate *(five year average)*

6. Change in discount rate *(measured as % change over five years)*

7. Change in end-of-year endowment value *(three year average)*

8. Instructional expenditures per unduplicated FTE *(three year average)*

9. Library expenditures per unduplicated FTE *(five year average)*

10. Alumni giving rate (USNWR)

          vi.   Domain 6 – Performance indicators:

                1.   Bachelor's degrees conferred per 100 UG FTE *(five year average)*

                2.   One-year retention rate of FTFT UG students *(five year average)*

                3.   Six-year graduation rate of FTFT UG students *(five year average)*

                4.   Six-year graduation rate of URM UG students *(five year average)*

                5.   Six-year graduation rate of Pell eligible UG students *(three year average)*

    b.   Note: The key performance indicators (Domain 6) are "outputs," i.e. high-level measures of institutional quality. The other five domains consist of "inputs," i.e. variables that will theoretically predict or influence the outputs.

    c.   The Institutional Characteristics (Domain 1) are categorical. These and other variables were included to provide context about qualitative differences between institutions. In general, these variables were intended to be used as "eliminators" rather than predictors. For example, the inclusion of schools with enrollment between 5,000-9,999 adds almost 200 institutions to the overall pool, any of which could summarily be disqualified simply based on their size relative to BU.

5. **Data preparation.** All variables listed in 4.a. (Domains 1 through 6) were downloaded from the NCES website, Carnegie Classification database, NCAA and NAIA, and other sources.

    a.   Various transformations were conducted to create five-year averages and rates of change.

    b.   Data were standardized. Per Kaufman, Leonard, and Rousseeuw in *Finding groups in data: An introduction to cluster analysis* (1990/2005), standardization of continuous variables is appropriate when data use different scales of measurement. This technique improves the trustworthiness of results by reducing the effect of multicollinearity and helping prepare the data for statistical tests that rely on Euclidian geometry to determine the nearest neighbor, e.g. k-means or weighted-average techniques. Standardization also aids in the identification of potential outliers that may increase bias in the results.

    c.   The full dataset was retained for the entire pool of 521 institutions. However, the IR&E team (and eventually the full IR&E + AAIE team) reviewed the variables to determine a list of appropriate predictors to include and their relative importance for the subsequent weighted z-score analysis and hierarchical cluster analysis.

    d.   D'Allegro and Zhou (2012) and D'Allegro (2016) recommend selecting a single variable from each of the non-KPI domains. Selection of a single predictor variable is achieved by regressing each of the key performance indicators (e.g. retention and four/six-year graduation rates) separately on all the variables in each non-KPI domain. The resulting beta weights indicate which *single* variable within a given domain has the most predictive power relative to its absence from the model (Cohen & Cohen, 1983). Using the single

variable effectively reduces the influence of bias caused by collinearity among predictor variables that represent similar constructs. For example, a strong correlation between net tuition revenue, discount rate, and yield rate could result in artificially weighting the importance of admissions criteria in selecting true peers. This approach was discussed but not adopted; the IR&E/AAIE team evaluated the importance of individual predictor variables qualitatively and weighted them with respect to Bellarmine's strategic plan.

e. As suggested by Hom (2008), a proximity matrix (or distance matrix) is also an invaluable step to evaluate differences within clusters, i.e. the distance between a single institution and the center of the cluster to which it belongs.

f. Possible limitation: In determining which variables to use, it could be useful to survey administrators, faculty, and staff about the extent of their confidence in each variable to benchmark BU's quality reliably. IR&E could conduct this survey in addition to planned vetting with the Cabinet. Although research suggests that a "wisdom of the crowds" appraisal of potential variables may not increase their predictive validity, it would also represent the value Bellarmine leadership places on transparency and shared governance.

6. **Analysis methods for peer institutions.** The list of peer institutions was developed by a process of ranking and exclusion using weighted z-scores and average linkage hierarchical cluster analysis.

   a. First, an array of the three most critical variables and their respective weights was established. This list was used to identify and potentially eliminate obviously dissimilar institutions based on two or more variables being more than one standard deviation away.

Variable name	Weight
Six-year graduation rate	50 %
One-year retention rate	30 %
Net Tuition Revenue per FTE	20 %
	100 %

   This yielded a new pool of 413 institutions, down from the original list of 521.

   b. For the remaining institutions, ten variables and their respective weights were developed:

Variable name	Weight
Six-year graduation rate	15.00 %
One-year retention rate	12.50 %
Net Tuition Revenue per FTE	12.50 %
Discount rate	12.50 %
Tuition and fees	10.00 %
Instruction expenses per FTE	10.00 %
Instruction % of total expenses	10.00 %
Fall student FTE	6.25 %
Admissions yield	6.25 %
Endowment value	5.00 %
	100.00 %

Subsequent efforts to reduce multicollinearity between these variables resulted in the following list of eight variables and their respective weights:

Variable name	Weight
Six-year graduation rate	20.0 %
One-year retention rate	15.0 %
Net Tuition Revenue per FTE	15.0 %
Instruction expenses per FTE	15.0 %
Instruction % of total expenses	12.5 %
Fall student FTE	8.0 %
Admissions yield	8.0 %
Endowment value	6.5 %
	100.0 %

c. After weighting the variables, the z-score distances were evaluated using hierarchical cluster analysis. This process generates a proximity matrix, i.e. a grid containing relative proximity scores for each institution versus every other institution. Centering BU's score in this dataset creates a dissimilarity score whereby Bellarmine has a score of zero and every institution has a positive value ranging from 0.029 through 2.002—indicating the extent of the institution's dissimilarity from Bellarmine. Sorting this list from lowest to highest score reveals the list of "nearest neighbor" institutions:

Institution Name	State	Proximity Score
Bellarmine University	Kentucky	0.000
North Central College	Illinois	0.040
Merrimack College	Massachusetts	0.047
King's College	Pennsylvania	0.057
Arcadia University	Pennsylvania	0.058
Florida Southern College	Florida	0.059
Salve Regina College	Rhode Island	0.060
Mount St. Mary's University	Maryland	0.060
Hamline University	Minnesota	0.062
Springfield College	Massachusetts	0.065
Marywood University	Pennsylvania	0.073
Canisius College	New York	0.073
Mercyhurst University	Pennsylvania	0.074

d. One institution (St. Catherine University) was excluded during *post hoc* qualitative review because it is not coeducational, leaving twelve institutions on the peer list.

All twelve institutions' proximity scores are below the 4th percentile of difference from Bellarmine's centered proximity score.

7. **Analysis methods for aspirant institutions.** The list of aspirant institutions was developed by a similar process of ranking and exclusion using weighted z-score analysis and average linkage hierarchical cluster analysis to generate clusters of similar institutions.

a. Unlike the methods used for the peer institution list—which emphasized each institution's dissimilarity score relative to Bellarmine—the goal of this process was to establish a list of similar institutions to one another, which could serve for the next 5-7 years as a bellwether of institutional quality and improvement. The variables for the aspirant list were limited to those that could be conceptualized as a positive construct (i.e. "where we'd like to be in 5-7 years") and that were notionally within Bellarmine's control.

Variable name	Weight
Six-year graduation rate	30 %
One-year retention rate	25 %
Net Tuition Revenue per FTE	25 %
Instruction Expenses per FTE	20 %

b. Hierarchical cluster analysis was used to generate twelve clusters of like institutions based on these new variable weights. Cluster size ranged from one institution (indicating an extreme outlier) to 77 institutions (indicating broad similarity) with a median of 27. These twelve clusters were evaluated to identify a single cluster with all four variables in a positive direction from Bellarmine and no more than a half standard deviation away. One cluster emerged as a candidate:

Cluster #6	State
Adelphi University	New York
Belmont University	Tennessee
Bryant University	Rhode Island
Columbia College Chicago	Illinois
Florida Institute of Technology	Florida
Lawrence Technological University	Michigan
Lincoln Memorial University	Tennessee
Manhattan College	New York
Marist College	New York
Molloy College	New York
Monmouth University	New Jersey
Saint Edward's University	Texas
St. Thomas Aquinas College	New York
University of Detroit Mercy	Michigan
University of New England	Maine
University of Saint Joseph	Connecticut
Wagner College	New York

c. These institutions were sorted by proximity score to find the twelve institutions with the closest scores to Bellarmine.

d. Three institutions (Columbia College Chicago, Lawrence Technological University, and Lincoln Memorial University) were excluded because their one-year retention rate and

six-year graduation rate are substantially below the Cluster #6 average and hence below Bellarmine's average for both metrics.

e. An additional institution (Bryant University) was excluded because of its business-heavy curriculum—all students in the College of Arts & Sciences are required to have a business minor.

f. A final institution (University of Detroit Mercy) was excluded because its URM enrollment is nearly 60% and its academic program mix includes a law school, dentistry school, and doctoral engineering program.

g. The remaining nine institutions are listed below, with their corresponding proximity score from Bellarmine. Note: This version of the proximity score includes the same variables as used in the peer methods, hence this list contains a larger spread of scores than would be the case if the proximity scores were derived only from the four aspirant variables.

Institution Name	State	Proximity Score
Bellarmine University	Kentucky	0.000
Saint Edward's University	Texas	0.053
Wagner College	New York	0.055
Monmouth University	New Jersey	0.082
Manhattan College	New York	0.158
University of Saint Joseph	Connecticut	0.205
Belmont University	Tennessee	0.209
Adelphi University	New York	0.227
Molloy College	New York	0.345
Marist College	New York	0.410

All nine institutions' proximity scores are within the 2nd and 20th percentile of difference from Bellarmine.