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Interim Deliverable 1

Introduction

The objective of this project is to investigate the possibility of applying optimization to improve the efficiency of current course scheduling system in USC Marshall School of Business and to quantify the potential gains behind the optimization model. For this interim deliverable 1 specifically, the goal is to identify one opportunity for improvement, define a metric to precisely measure the current status quo of our process, and provide evidence on why such metric would be an appropriate choice.

Opportunity for Improvement

Given that the future demand for Marshall courses is expected to rise, and the school is planning to undertake a large-scale renovation of the Bridge and Accounting buildings, It is important that the new optimization model should efficiently utilize the available space. However, our team believe that it is equally important to maintain a high education quality throughout this transition. Thus, our team chooses education quality as one of the focuses for this project.

This notion of education quality is particularly important to Marshall's Board of Administration and the students – two major stakeholders in this project. Firstly, it is important to the board of administration because education quality directly influences the ranking, reputation, and the Marshall brand in the higher education market. The better education quality provided, the more influential and prestigious the Marshall brand becomes. On the other hand, education quality is also important to the students who take Marshall courses because they are the immediate beneficiaries of such policy. In other words, their educational experience and satisfaction are directly impacted by the quality provided.

Metric

To precisely measure this concept of "education quality", our team choose *student-faculty ratio* as our metric because this is a widely used ratio by various media outlets to judge the quality of an education institute.[1] Conceptually, this metric is simply the number of students divided by the number of instructors per course. We can then aggregate this ratio at the departmental level or at the level of Marshall as a whole. In the next section, we will further discuss the computation of this metric, and why and how it is correlated with the notion of education quality that we are trying to measure.

CASE Principle

Computable

From the course enrollment dataset, we can easily compute an overall Marshall student-faculty ratio by summing up the actual enrollments and then dividing by total courses offered in Marshall. Also, we can compute student-faculty ratio for each department by averaging the total enrollments of each department. The following are formulas for our metrics:

Student-faculty ratio for Marshall = Total enrollments / total courses offered

[1] For example, USC ranks #21 nationally by USNews, and the student-faculty ratio is reported as 8:1 (https://www.usnews.com/best-colleges/usc-1328).

Student-faculty ratio for each department = Total enrollments of each department/ total courses offered by each department

Actionable

When scheduling courses, there are possible factors that will influence scheduling decisions and in turn, indirectly affect our metric. For example, some departments might require larger size classrooms since they have more students in total. When a larger size classroom is assigned to a certain course, more seats can be offered and possibly, more students will be enrolled. In this case, the student-faculty ratio for that particular department and for Marshall will increase respectively. On the contrary, if a department would like to maintain the education quality by controlling the size of class to a small size, it might provide multiple sections for students and thus require multiple small size classrooms. In this case, the overall Marshall student-faculty ratio and the student-faculty ratio of that particular department will both decrease.

In a broader picture, as we are expecting a rising demand for Marshall courses and a large scale renovation, it is likely that courses will be consolidated due to limited classroom space. As a result, it is important that we have a metric to measure the education quality and ensure that our quality standard is appropriately maintained throughout this transition.

Simple

The student-faculty ratio is a straightforward metric that is easy to interpret and understand. For the purposes of this analysis, we calculated the student-faculty ratio using the number of students enrolled in the class as the student variable. This ratio represents the actual ratio of student to teacher attained for that course.

We can interpret ratio in the context of different departments within Marshall and Marshall overall. If the ratio is too large relative to the computed Marshall average ratio, this indicates that the actual number of enrolled students is too high. Likewise, if the computed ratio falls below the average, the actual number of enrolled students is too low.

We plotted a comparison of each department's real student-faculty ratio with the corresponding average for all of Marshall. This visualization shows the variation among the departments and different trends, such as the percentage of departments that fall above and below the average.

These analyses and interpretations can help in deciding appropriate measures to take in the future.

Enlightening

The student-faculty ratio has a close relationship with the goals of optimal efficiency and satisfaction, and thus is a good metric to be utilized in light of these goals. Through applying this metric, we can pinpoint which departments deviate the most from the average, and whether those departments should be set as high priority or not. This process also provides insight on department preferences, as well as points of satisfaction and dissatisfaction.

By using the student-faculty ratio as a metric, we can tackle the question of whether deviating from the mean is bad or good in the context of scheduling efficiency. In this way, the student-faculty ratio can act as a measure of goodness. When the student-faculty ratio for a course reaches a certain threshold, it indicates a high quality education. In our case, we set this threshold as the average Marshall student-

faculty ratio. We can categorize ratios on a scale of good to bad based on this standard. One potential solution to create a more efficient scheduling process is to standardize the student-faculty ratio across all departments in Marshall. By increasing or decreasing ratios to a certain point, we can implement a high quality education level across all of Marshall. However, we must also take into consideration the preferences of different departments, as well as professors and students.

The student-faculty ratio provides insight into preferences and satisfaction levels– past student-faculty ratios provide an idea of the nature and personality of each department and Marshall as a school overall. For example, some departments may prefer larger class sizes for particular courses and purposefully set a higher seating cap, less course section offerings, and thus create a higher enrollment number for that course. While we have no actual data on personal preferences and satisfaction levels, this data can provide some indication of what worked and was potentially liked or disliked in the past.

By using the student-faculty ratio and gaining analytical insights, we can come up with appropriate solutions to optimize scheduling efficiency while taking into consideration of department, teacher, and student preferences.

Analysis of Available Data Using Metric

- Data:

Three columns (department, reg count) from "Marshall_Course_Enrollment_1516_1617.xlsx" data file.

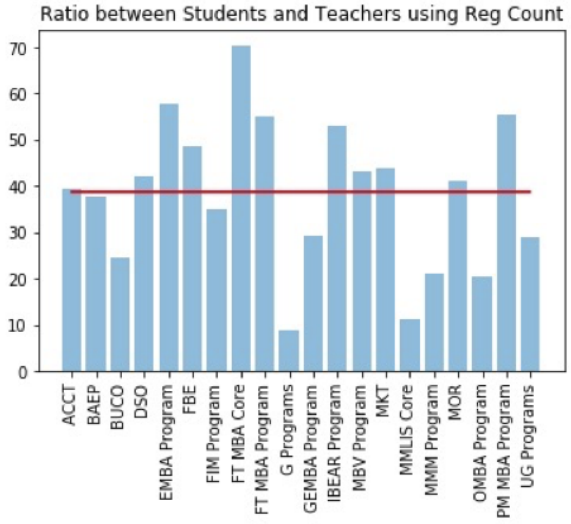
- Steps:

Calculated the ratio of students to teachers by different departments.

- Results:

The column reg_count_department calculated using enrollment number. Generally, we assume that there is only one teacher in each course and the lower ratio of students to teachers means a better education environment. Also, the ratio of students to teachers for the entire Marshall school is calculated by reg count to be 39 students per teacher.

department_name	reg_count_department
ACCT	39.476378
BAEP	37.786096
BUCO	24.527439
DSO	42.077586
EMBA Program	57.714286
FBE	48.650386
FIM Program	35.000000
FT MBA Core	70.333333
FT MBA Program	55.125000
G Programs	8.807692
GEMBA Program	29.117647
IBEAR Program	53.000000
MBV Program	43.166667
MKT	43.693141
MMLIS Core	11.121622
MMM Program	21.000000
MOR	41.262087
OMBA Program	20.428571
PM MBA Program	55.272727
UG Programs	28.851351



- Analysis:

Based on the graphs above, 11 out of 20 departments' student-faculty ratios are more than the average Marshall ratio of 39, including the DSO department. In order to improve this aspect of Marshall school, we should balance teacher resources and offer a better academic environment to the students.

Inefficiency

For our analysis, the status quo can be interpreted as the standardized ratio we would like to implement across all of Marshall: the average Marshall student-faculty ratio of 39. Based on this benchmark of 39, we discovered several critical points of inefficiency throughout our analysis. We base these conclusions on the fact that the greater the deviation from the benchmark, the higher the level of inefficiency exhibited.

The first most inefficient point we found was the department that deviated the most from 39, FT MBA Core, which had a ratio of around 70. For this department, on average there were around 31 more students in every course. Another inefficient point we noticed was the G Programs, with a student-faculty ratio of 8.80762. This is around 30 students below reaching the benchmark level of 39. This indicates that on average, for every course in the G Program department there were around 30 less students relative to the average number of students in a Marshall course.

Other inefficient departments that fell short of the benchmark included MMILS Core, MMM Program, OMBA Program. On average, for the top 4 courses ranking below this benchmark, there were around 24 students lower than the benchmark level.

Similarly, like FT MBA Core, the EMBA Program, FT MBA Program, and PM MBA Program all ranked high above the benchmark. For these top four programs sitting above the benchmark, on average for every teacher, and thus for each course, there were around 20 students greater than the benchmark level.

Our metric is useful here because we can see to what degree these departments fall short of or sit above the desired benchmark. From there, we can come up with alternative solutions for raising or lowering the ratios and ultimately, reach our goal of standardizing the student-faculty ratio and obtaining a higher level of education across Marshall School. Without resolving these inefficiencies, it is unclear how much damage the future school renovations can have on the overall education quality at Marshall.

project_phase1copy

March 6, 2018

In [1]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
```

In [2]:
```
enrollment=pd.read_excel("Marshall_Course_Enrollment_1516_1617.xlsx")
```

In [3]:
```
enrollment.head()
```

Out[3]:

	Course	Course Prefix	Course Suffix	Department	First Begin Time
0	ACCT-370	ACCT	370	ACCT	10:00:00
1	ACCT-370	ACCT	370	ACCT	08:00:00
2	ACCT-370	ACCT	370	ACCT	10:00:00
3	ACCT-370	ACCT	370	ACCT	12:00:00
4	ACCT-371	ACCT	371	ACCT	10:00:00

	First Days	First End Time	First Instructor	First Instructor UID
0	F	11:50:00	Hopkins, Merle, W	3.783354e+09
1	MW	09:50:00	Hopkins, Merle, W	3.783354e+09
2	MW	11:50:00	Hopkins, Merle, W	3.783354e+09
3	MW	13:50:00	Hopkins, Merle, W	3.783354e+09
4	F	11:50:00	NaN	NaN

	First Room	...	Second Begin Time
0	SLH200	...	NaN
1	ACC303	...	NaN
2	ACC303	...	NaN
3	ACC303	...	NaN
4	SLH200	...	NaN

	Second Days	Second End Time	Second Instructor	Second Instructor UID
0	NaN	NaN	NaN	NaN
1	NaN	NaN	NaN	NaN
2	NaN	NaN	NaN	NaN
3	NaN	NaN	NaN	NaN
4	NaN	NaN	NaN	NaN

	Second Room	Section	Session	Term	Title
0	NaN	14029	1	20153	External Financial Reporting Issues

```
1          NaN   14025       1  20153  External Financial Reporting Issues
2          NaN   14026       1  20153  External Financial Reporting Issues
3          NaN   14027       1  20153  External Financial Reporting Issues
4          NaN   14044       1  20153   Introduction to Accounting Systems

[5 rows x 26 columns]
```

```
In [6]: ratio_reg_department=pd.DataFrame(enrollment.groupby(["Department"])["Reg Count"].mean
```

```
In [7]: ratio_reg_department.shape
```

```
Out[7]: (20, 1)
```

```
In [8]: # transfer the group by result to two columns
        def seperate1(ratio):
            reg_count_department=[]
            department_name=[]
            for i in range(len(ratio)):
                st=str(ratio.iloc[i,:]).split()
                reg_count_department.append(float(st[2]))
                st2=""
                for j in range(3):
                    if ((st[j+4]!="dtype:") & (st[j+4]!="float64")):
                        st2=st2+" "+st[j+4]
                st2=st2.replace(",","")
                department_name.append(st2)
            return reg_count_department,department_name
```

```
In [9]: reg_count_department,department_name=seperate1(ratio_reg_department)
        print(reg_count_department)
        print(department_name)
```

```
[39.476378, 37.786096, 24.527439, 42.077586, 57.714286, 48.650386, 35.0, 70.333333, 55.125, 8.8
[' ACCT', ' BAEP', ' BUCO', ' DSO', ' EMBA Program', ' FBE', ' FIM Program', ' FT MBA Core', '
```

```
In [15]: temp=pd.DataFrame({"department_name":department_name,"reg_count_department":reg_count_
         print(temp)
```

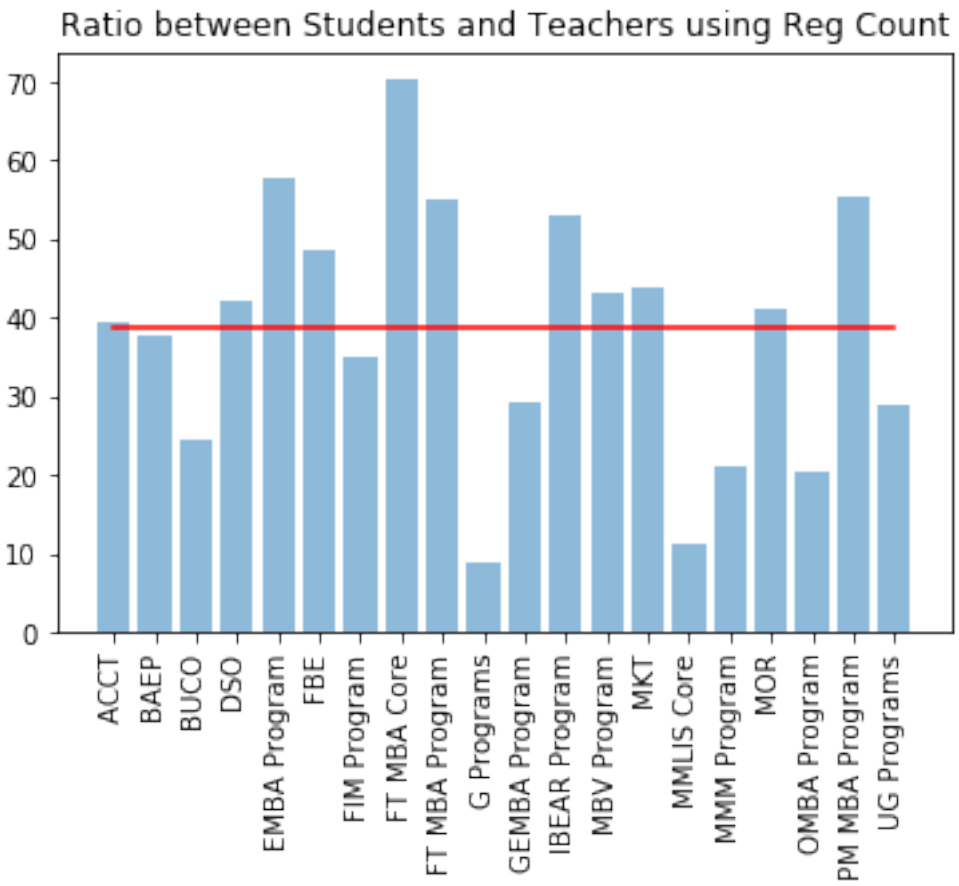
```
    department_name  reg_count_department
0              ACCT             39.476378
1              BAEP             37.786096
2              BUCO             24.527439
3               DSO             42.077586
4      EMBA Program             57.714286
5               FBE             48.650386
6       FIM Program             35.000000
7       FT MBA Core             70.333333
```

```
8    FT MBA Program            55.125000
9        G Programs             8.807692
10    GEMBA Program            29.117647
11    IBEAR Program            53.000000
12      MBV Program            43.166667
13              MKT            43.693141
14       MMLIS Core            11.121622
15      MMM Program            21.000000
16              MOR            41.262087
17     OMBA Program            20.428571
18   PM MBA Program            55.272727
19      UG Programs            28.851351
```

```
In [69]: marshall_reg_mean=enrollment["Reg Count"].mean()
         marshall_reg_mean
```

```
Out[69]: 38.793032080027594
```

```
In [29]: plt.bar(department_name,reg_count_department,align='center', alpha=0.5)
         plt.plot(department_name,data.loc[:,"marshall_reg_mean"],color="red")
         plt.xticks(rotation=90)
         plt.title("Ratio between Students and Teachers using Reg Count")
         plt.show()
```




```
In [62]: temp.to_csv("phase1.csv")
```