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# Understanding graduation rates at higher education institutions: A forecasting model

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# Understanding Graduation Rates at Higher Education Institutions: A Forecasting Model

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**ABSTRACT**

*Graduation rates and degree completion have always been a concern for students, students' families and universities. Moreover, many consider college degree completion rates to be among one of the most important indicators of institutional quality according to a report from the Higher Education Research Institute published in the United States of America. This research studied factors that can explain graduation rates which include student-faculty ratio, financial factors, and enrollment status. Data was collected and analyzed for state and private universities, and a Multiple Regression Model (MLR) was built to forecast graduation rates. The model was able to highlight variables that significantly relate to graduation rates. Researchers can use this article to understand the different factors that correlate with degree completion and to forecast graduations rates at Higher Education Institutions. The international researcher can explore replicating the forecasting model at universities outside the United States of America.*

**Introduction**

Graduation rates are usually defined as the time to complete a degree program within four to six years of starting the degree (Paterson & Gordon, 2010), and graduation rate has become one of the commonly regarded statistics as a primary indicator of institutional performance for higher education (DeAngelo, Franke, Hurtado, Pryor, & Tran, 2011). In the DeAngelo, et al. (2011) report published by the Higher Education Research Institute, the authors stated that high graduation rates are important to society because greater degree attainment is associated with higher salaries and lower unemployment rates; therefore, impacting the economic health of the United States. Recent research has shed the light on the importance of increasing graduation rates at higher education institutions (Haynes, 2016; Joy, 2017). Before 1985, institutional statistics on universities' graduation rates did not exist (Cook & Pullaro, 2010), and now graduation rates have come to reflect overall quality of student learning, intellectual involvement, how well students are integrated into campus life, and how effectively a campus delivers what students expect and need. For instance, in a study performed on Texas high schools, concluded that the accountability pressure on schools affected college graduation rates. In 1993, a test-based accountability system was introduced in Texas resulting in sanctions

put in place for underperforming schools (Deming, Cohodes, Jennings, & Jencks, 2016). This caused school officials to pressure students to achieve high test scores to avoid government punishments. The study found that this pressure affected students' college enrollment and completion rates as well as their job earnings as adults. Subsequently, students enrolled in underperforming schools had more pressure to do well on state tests which resulted in an increase in students' college enrollment and competition rates. Thus, the study found that high school accountability influences graduation rates. However, this paper proposes that the relative size of the college's student population, financial factors, and enrollment statuses has a statistically significant relationship with the institutional dedication to the student and ultimately the graduation rate. This paper chose to focus on these factors to determine whether our hypothesis holds true for over 1000 higher education institutions universities in the United States of America as shown in the conceptual model section.

This paper is divided into six sections. The first section introduces the topic and the need for a model to forecast graduation rates. The second section reviews and integrates the available literature history and the main authors that addressed graduation rates. The third section proposes a conceptual model that addresses the variables that predict graduation rates. The fourth section explains the data collection and analysis processes, the fifth section discusses the results and its implications, and the sixth section summarizes the paper with an overall conclusion and areas for future research.

**Literature Review**

Graduation rates have continued to be a popular indicator of institutional performance. Other studies have been performed about college graduation rates using different variables than this study. For instance, eight cohorts of undergraduate college students in the 1990s were studied resulting in the conclusion that there is a positive correlation between state funding and college graduation rates (Zhang, 2009). It was found that for every 10% increase in state funding, there was a 0.64% increase in graduation rates per full-time student. The author concluded that "it is the interaction between student characteristics (including commitments to their educational goals and institutions and the academic and social contexts of the institutions that ultimately determines students' college persistence and graduation" (Zhang, 2009, p. 716).

Additionally, Montgomery and Beronda (2012) used this same study as a resource for their study on graduation rates. In their study, they compared graduation rates of ten historically black colleges and ten predominately white institutions. While their main independent variable was race, they also used other variables such as geographical location, socioeconomic factors, and population size. Their results suggested that historically black colleges have lower graduation rates; thus, affecting state funding. Both Zhang's, and Montgomery's and Beronda's studies used graduation rates as a performance measure for determining funding levels. Furthermore, both studies used the Integrated Postsecondary Education Data System which

this paper also utilized with the difference being that this study used data from more recent years.

Similar to Montgomery's and Beronda's study, Mooring and Mooring (2016) hypothesized that the graduation rates for minority community college transfer students vary and that the factors that best predict timely graduation also vary by ethnicity. They found that their hypotheses were valid. The results concluded that the most predictive factor for African American transfer students was enrollment in a four-year transfer program at the community college while the predictive factor for Hispanic Americans was obtaining a credential before transferring. Furthermore, a high GPA was the best predictive factor for Asian American transfer students.

Another study utilized prediction models using graduation rates as a performance indicator of community colleges (Moosai, Walker, & Floyd, 2011). Therefore, this study was not focused on what specific variables impact graduation rates, but was more concerned with how graduation rates could predict a higher education institution's performance. From this study using data from California, Florida, and Michigan community colleges, the results concluded that graduation rates could predict whether a college was exceeding, meeting, or below expectations. Yet, the researchers warned that the performance of an institution consists of numerous factors, not just graduation rates. Thus, this study will determine which major variables are significantly related to graduation rates which can predict institutional performance.

Another community college study used a regression model to compare the differences in graduation rates between students who transferred from community colleges to students who stayed at the college for all four years (Friedl, Pittenger & Sherman, 2012). They examined 417 University of Tennessee students and compared the performance of students who had previously taken an intermediate math course at a community college with those who had taken the same course at a four-year institution. It was found that the students who transferred performed poorer in college-level math courses at the university suggesting that community college transfer students may result in decreasing a university's four-year graduation rate.

Additionally, Melguizo (2008) found that the selectivity of institutions impacted graduation rates. In her study, Melguizo sampled 3,000 students across the nation. While this study used three specific independent variables, Melguizo used three sets of variables: student characteristics, pre-college achievement, and postsecondary institutional characteristics. Her regression analysis concluded that students who attended the most selective universities were more likely to graduate with a bachelor's degree.

Instead of just focusing on student characteristics, Crawford's (2015) study solely focused on the impact on institutional expenses. From his study using ANOVA, Crawford discovered that library and instruction expenses had a strong, positive correlation with college retention and graduation rates. Thus, he concluded that since private schools typically have larger funds for

library and instruction expenses, more students graduate from private than public colleges, on average. Additionally, Crawford's results can support Melguizo's study about the impact of the selectivity of schools. From both studies, it can be hypothesized that since private schools tend to be more selective and have more funding that they have higher graduation rates than public colleges and universities.

**Conceptual Model**

Previous studies have successfully determined factors that impact graduation rates and how graduation rates impact institutional performance. However, none of the studies specifically focused on areas related to the number of applications received and accepted, student enrollment size, financial factors, enrollment statuses and student/faculty ratio. Furthermore, none of the studies had a similar scope as this research since this paper is using data from 1,155 higher education institutions across the United States.

This research proposed a framework that will predict graduation rates based on multiple independent variables including applications received, applications accepted, new students enrolled, part-time undergrads, out-of-state tuition and student/faculty ratio.

**Figure 1** shows the multiple variables addressed in this paper. As shown in the conceptual model, this research focused on understanding the potential relationships between graduation rates (dependent variable) and the six independent variables in order to forecast the graduation rates.
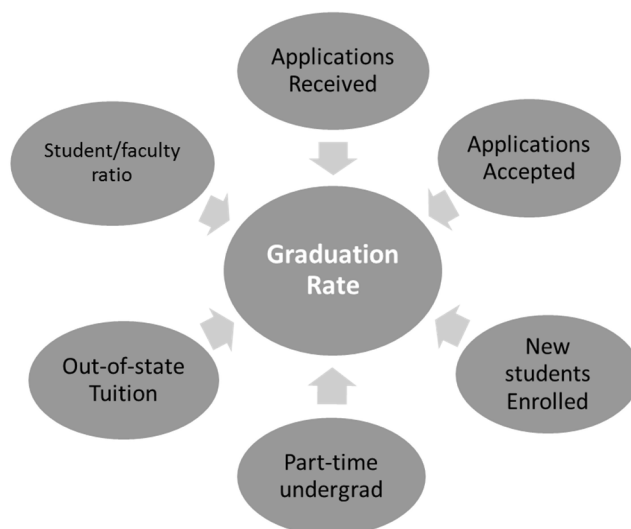
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**Figure 1: The Conceptual Model Dependent and Independent Variables**

**Variables Definitions**

The six independent variables are defined as follows:

- Number of applications received: Total number of applications that were submitted to the school in the school year documented.
- Number of applications accepted: Number of applications that were submitted and accepted for spring or fall entry by the university or college.
- Number of new students enrolled: Number of new students entering the university at the start of the August or fall semester.
- Number of part time undergraduate: Total number of undergraduates in the program that are part-time students as defined by the university or college (typically less than 12 credits).
- Out of state tuition: Amount of tuition paid by students that are commuting out of state.
- Student/faculty ratio: Ratio of students to faculty members in the university.

The dependent variable in this paper is Graduation Rate. This variable is the percentage of a higher education institution's first-time, first-year undergraduate students who complete their program within 150% of the published time. In this proposed conceptual model, graduation rate is considered exclusively for four-year programs.

The following section describes the data collection and the analysis processes this study implemented.

**Data Collection and Analysis**

**Research Main Question.**

The main question in this research paper was what can forecast graduation rates? To answer this question, the following hypothesis was proposed and tested:

- Research Hypothesis
  - $H_0$ (null hypothesis): There is no correlation between "Applications Received, Applications Accepted, New students Enrolled, Part-time undergrads, Out-of-state Tuition and Student/faculty Ratio" and "Graduation Rates."
  - $H_1$ (alternative hypothesis): There is a correlation between "Applications Received, Applications Accepted, New students Enrolled, Part-time undergrads, Out-of-state Tuition and Student/faculty Ratio" and "Graduation Rates."

**Data Collection Approach.**

Data from 1,155 colleges across the nation was collected from the U.S News and World Report (National Universities Ranking, 2016), universities' websites, and phone calls to the universities made to verify any old/missing data. The number of higher education institutions collected grouped per state is shown in Table 1.

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Table 1
*Number of Higher Education Institutions per State*

| State | # of HE Institutions | State | # of HE Institutions |
|---|---|---|---|
| Alaska | 2 | Montana | 7 |
| Alabama | 24 | North Carolina | 44 |
| Arkansas | 12 | North Dakota | 7 |
| Arizona | 4 | Nebraska | 14 |
| California | 61 | New Hampshire | 11 |
| Colorado | 13 | New Jersey | 26 |
| Connecticut | 16 | New Mexico | 8 |
| District of Columbia | 6 | Nevada | 2 |
| Delaware | 4 | New York | 89 |
| Florida | 25 | Ohio | 44 |
| Georgia | 35 | Oklahoma | 13 |
| Hawaii | 2 | Oregon | 13 |
| Iowa | 28 | Pennsylvania | 78 |
| Idaho | 6 | Rhode Island | 7 |
| Illinois | 47 | South Carolina | 24 |
| Indiana | 36 | South Dakota | 9 |
| Kansas | 20 | Tennessee | 30 |
| Kentucky | 21 | Texas | 51 |
| Louisiana | 20 | Utah | 5 |
| Massachusetts | 48 | Virginia | 37 |
| Maryland | 21 | Vermont | 13 |
| Maine | 12 | Washington | 15 |
| Michigan | 33 | Wisconsin | 27 |
| Minnesota | 24 | West Virginia | 15 |
| Missouri | 31 | Wyoming | 1 |
| Mississippi | 14 | | |

The detailed statistics of the six interdependent variables: applications received, applications accepted, new students' enrolled, part-time undergrads, out-of-state tuition and student/faculty ratio, are shown in Table 2.

Table 2

*Statistics of the Six Interdependent Variables per State*

| State | Sum of app. Received | Sum of app. Accepted | Sum of new Students Enrolled | Sum of Part-time Undergrads | AVG of out-of-state Tuition | AVG of Student/faculty Ratio |
|---|---|---|---|---|---|---|
| Alaska | 339 | 263 | 144 | 2,718 | $ 6,393 | 10.7 |
| Alabama | 48,797 | 36,839 | 17,795 | 23,264 | $ 5,368 | 16.6 |
| Arkansas | 19,603 | 17,078 | 10,808 | 11,181 | $ 5,161 | 16.3 |
| Arizona | 33,276 | 27,870 | 10,432 | 15,615 | $ 7,121 | 18.6 |
| California | 266,518 | 172,911 | 54,577 | 82,157 | $ 11,461 | 14.4 |
| Colorado | 51,705 | 36,058 | 14,420 | 18,811 | $ 8,821 | 19.7 |
| Connecticut | 60,265 | 35,503 | 11,497 | 18,359 | $ 12,936 | 12.7 |
| District of Columbia | 35,380 | 16,348 | 6,201 | 4,473 | $ 13,989 | 8.9 |
| Delaware | 17,334 | 13,066 | 4,521 | 6,980 | $ 7,893 | 18.2 |
| Florida | 77,542 | 53,498 | 21,190 | 56,376 | $ 8,843 | 16.3 |
| Georgia | 95,097 | 59,786 | 28,922 | 36,455 | $ 6,756 | 15.2 |
| Hawaii | 5,079 | 3,382 | 2,127 | 3,282 | $ 3,690 | 13.8 |
| Iowa | 44,683 | 37,977 | 15,875 | 15,137 | $ 10,783 | 13.8 |
| Idaho | 10,945 | 9,050 | 5,333 | 10,292 | $ 6,836 | 13.9 |
| Illinois | 122,948 | 86,174 | 34,133 | 39,473 | $ 10,202 | 13.6 |
| Indiana | 101,685 | 81,821 | 37,576 | 49,032 | $ 9,651 | 14.4 |
| Kansas | 28,339 | 21,788 | 12,443 | 16,025 | $ 7,349 | 14.8 |
| Kentucky | 41,229 | 32,340 | 16,667 | 24,066 | $ 6,863 | 14.5 |
| Louisiana | 52,691 | 45,484 | 25,335 | 27,746 | $ 5,744 | 18.0 |
| Massachusetts | 159,329 | 100,911 | 34,191 | 46,978 | $ 12,830 | 13.3 |
| Maryland | 63,458 | 39,904 | 13,379 | 19,927 | $ 10,117 | 13.9 |
| Maine | 17,376 | 11,453 | 4,731 | 6,674 | $ 9,865 | 15.9 |
| Michigan | 110,967 | 86,944 | 37,324 | 62,464 | $ 9,085 | 17.7 |
| Minnesota | 52,159 | 37,924 | 19,580 | 34,144 | $ 10,212 | 14.5 |
| Missouri | 60,632 | 48,425 | 22,156 | 38,318 | $ 8,183 | 14.9 |
| Mississippi | 29,305 | 18,985 | 9,172 | 8,120 | $ 5,582 | 16.0 |
| Montana | 9,782 | 8,241 | 5,045 | 5,175 | $ 6,692 | 16.6 |
| North Carolina | 127,170 | 76,746 | 31,553 | 27,820 | $ 8,395 | 13.8 |
| North Dakota | 7,911 | 6,546 | 4,550 | 3,400 | $ 5,548 | 16.4 |
| Nebraska | 21,724 | 20,423 | 10,792 | 13,563 | $ 6,808 | 15.0 |
| New Hampshire | 33,547 | 22,531 | 6,498 | 8,689 | $ 12,276 | 16.2 |
| New Jersey | 129,267 | 66,899 | 18,576 | 39,184 | $ 9,094 | 15.5 |
| New Mexico | 12,487 | 10,581 | 5,469 | 11,478 | $ 6,071 | 16.1 |
| Nevada | 3,068 | 2,569 | 1,624 | 2,989 | $ 6,995 | 11.5 |
| New York | 336,847 | 210,346 | 67,668 | 94,222 | $ 11,037 | 14.0 |

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| Ohio | 131,720 | 103,317 | 48,317 | 53,355 | $ 1,117 | 14.4 |
|------|---------|---------|--------|--------|---------|------|
| Oklahoma | 21,597 | 18,859 | 10,540 | 14,509 | $ 5,803 | 17.0 |
| Oregon | 25,936 | 20,742 | 7,369 | 5,034 | $ 12,046 | 14.2 |
| Pennsylvania | 226,449 | 145,665 | 50,958 | 56,339 | $ 11,784 | 13.7 |
| Rhode Island | 36,655 | 21,950 | 7,106 | 9,640 | $ 12,896 | 14.8 |
| South Carolina | 45,498 | 33,852 | 14,203 | 12,738 | $ 7,947 | 15.7 |
| South Dakota | 8,605 | 7,719 | 5,474 | 4,972 | $ 6,146 | 16.1 |
| Tennessee | 59,939 | 42,992 | 20,739 | 25,894 | $ 7,497 | 14.3 |
| Texas | 134,473 | 99,820 | 53,111 | 83,262 | $ 6,431 | 17.0 |
| Utah | 17,694 | 14,762 | 9,834 | 16,728 | $ 5,505 | 17.6 |
| Virginia | 118,319 | 72,610 | 27,200 | 21,749 | $ 10,084 | 13.6 |
| Vermont | 19,847 | 13,944 | 4,769 | 4,038 | $ 13,164 | 11.9 |
| Washington | 45,755 | 31,896 | 12,982 | 11,046 | $ 10,718 | 14.9 |
| Wisconsin | 71,058 | 55,233 | 23,701 | 28,221 | $ 9,722 | 15.6 |
| West Virginia | 28,214 | 23,631 | 10,762 | 10,803 | $ 7,881 | 14.6 |
| Wyoming | 2,029 | 1,516 | 1,073 | 1,488 | $ 5,988 | 15.1 |

**Data Analysis.**

Standard multiple regression analysis was performed to test the research hypothesis. A multiple linear regression (MLR) model was constructed with the six interdependent variables discussed in section 0 all 1,155 higher education institutions and the dependent variable "Graduation Rate". The results of the hypotheses testing using standard multiple regression are shown in Table 3 and the detailed MLR output is shown in Table 4 and Table 5.

Table 3
*Results of Hypothesis Testing*

| Relationship Strength | Significant Relationship | Significance Level | Significant Contribution |
|-----------------------|--------------------------|--------------------|--------------------------|
| $R^2$ = 0.426 | Yes | 0.00 < 0.05 | • Number of applications received<br>• Number of Part-time undergrad<br>• Out-of-state tuition |

Table 4
*The Results of the Multiple Linear Regression Model for Graduation Rates*

| Regression Statistics | |
|-----------------------|---|
| **Coefficient of Determination ($R^2$)** | 0.425752 |

Table 5
*Multiple Linear Regression Output*

| | Coefficients | Standard Error | t Stat | P-value |
|---|--------------|----------------|--------|---------|
| Intercept | 39.77871 | 2.27782 | 17.4635 | 0.00000 |
| Number of applications received | *0.001411* | *0.000361* | *3.908984* | *0.00010* |

| | | | | |
|---|---|---|---|---|
| Number of application accepted | -0.00055 | 0.000659 | -0.83221 | 0.40547 |
| Number of new student enrolled | -0.00039 | 0.001087 | -0.35874 | 0.71986 |
| Number of Part-time undergrad | *-0.00242* | *0.000296* | *-8.1865* | *0.00000* |
| Out-of-state tuition | *0.002337* | *0.000122* | *19.09706* | *0.00000* |
| Student/faculty ratio | -0.10323 | 0.101047 | -1.0216 | 0.30718 |

The results in Table and Table 4 show that this research conceptual model that includes applications received, applications accepted, new students enrolled, part-time undergrads, and out-of-state tuition and student/faculty ratio explains almost 43% of the variation in the graduation rate.

### The Refined Conceptual Model.

In order to find the significant unique contribution of individual variables on the dependent variable, the observed levels of significance (p-value) were examined. The three variables that significantly relate to the dependent variable (graduation rate) are number of applications received, number of part-time undergrads and out-of-state tuition.

To improve the forecast of the developed MLR model, only the significant variables with p-value of 0.0 (in bold italic in Table 5) were included and a refined MLR model was built as shown in Table 6 and Table 7.

Table 6
*The Results of the Refined Multiple Linear Regression Model for Graduation Rates*

| Regression Statistics | |
|---|---|
| **Coefficient of Determination (R²)** | 0.424297 |

Table 7
*Refined Multiple Linear Regression Output*

| | Coefficients | Standard Error | t Stat | P-value |
|---|---|---|---|---|
| **Intercept** | 37.37284 | 1.175189 | 31.80155 | 0.00000 |
| **Number of applications received** | 0.000997 | 0.000125 | 7.978915 | 0.00000 |
| **Number of PT undergrad** | -0.00254 | 0.000279 | -9.10238 | 0.00000 |
| **Out-of-state tuition** | 0.002421 | 0.000107 | 22.71887 | 0.00000 |

The results in Table 6 and Table 7 show that the conceptual model that includes number of applications received, number of part-time undergrads and out-of-state tuition explains almost 42.4 % of the variation in the graduation rate and the three independent variables significantly relate to graduation rate.

The regression model shown in Equation 1 intended to forecast graduation rate. Equation 1 demonstrates the interrelationship between the research variables of graduation rate, number of applications received, number of part-time undergrads and out-of-state tuition.

$$Graduation\ Rate \cong 37.373 + 0.000997\ (number\ of\ applications\ received) - 0.00254\ (number\ of\ parttime\ undergrads.) + 0.00242\ (out-of-state\ tuition) \quad (1)$$

The positive contributions of number of applications received and out-of-state tuition demonstrate that the increase in these two variables positively correlates with an increase in graduation rate. The negative contribution of number of part-time undergraduates, however, demonstrates that the increase in the number of part-time undergraduates negatively correlates with graduation rate.

**Discussion**

Standard multiple regression analyses were performed to test the research hypothesis and found that the six variables discussed in this paper (applications received, applications accepted, new students enrolled, part-time undergrads, out-of-state tuition and student/faculty ratio) were able to explain almost 43% of the variation in the graduation rate.

The conceptual model was refined to include the three significant variables only (with p-value of 0.0) and the refined multiple regression model that includes number of applications received, number of part-time undergrads and out-of-state tuition was able to explain almost 42.4 % of the variation in the graduation rate.

The coefficient of determination ($R^2$) which explains how much variation in the dependent variable (graduation rate) was explained by the independent variables is almost the same when including all six variables; the significant and insignificant ones. Therefore, the significant variables were considered only when building the refined conceptual model.

The refined conceptual model showed that the number of applications received and out-of-state tuition positively relates to graduation rate while part-time undergraduates negatively relates to graduation rate.

To test the applicability and practical use of our model in forecasting graduation rates, the developed conceptual model in this research paper was used to forecast the graduation rates for two universities in Florida, USA as shown in Table.

Table 8
*A Forecasting Example*

| | No. of Applications rec'd | No. of PT undergrad | Out-of-state tuition | Actual Graduation rate | Forecasted Graduation Rate |
|---|---|---|---|---|---|
| Stetson University | 1557 | 81 | 12315 | 73% | 69% |
| University of Central Florida | 6986 | 7152 | 6618 | 46% | 42% |

The results in Table show that the multiple regression model developed in this research was able to forecast with close proximity the graduation rates at Stetson University and the University of Central Florida.

The ability to forecast graduation rates with such proximity could predict whether the educational institution was exceeding, meeting, or below expectations. This helps in institutional planning and reflects overall quality of student learning, intellectual involvement and how effectively a campus delivers what students expect and need.

**Conclusion and Future Research**

This section summarizes the results of this paper and how the research conceptual model, data collection and data analysis were able to predict graduation rates. The data collection and analysis performed in section 4 led to three significant variables that relate to graduation rate: number of applications received, number of part-time undergrads and out-of-state tuition. These three variables were able to explain 42.4 % of the variation in the graduation rate.

This research was able to reject the null hypothesis and support at 5% level of significance the alternative hypothesis that states: there is a correlation between "Applications Received, Applications Accepted, New students Enrolled, Part-time undergrads, Out-of-state Tuition and Student/faculty Ratio" and "Graduation Rates." The analysis showed that the increase in number of applications received and out-of-state tuition significantly increases graduation rate, while the increase in the number of part-time undergraduates significantly decreases graduation rates. Since the increase in the number of part-time undergraduates negatively relates to graduation rates, future research can look into institutional policies for hiring their part-time students to work on-campus as an incentive for them to become full-time students. In addition to the positive relationship this might have on graduation rates, students who work on-campus do not have to worry about commuting to work and have the opportunity to build strong connections with the institutions' faculty and staff. Further research can look into the commitment students work on-campus feel toward their degree completion and graduation when they have a secured job on-campus.

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Future research can consider developing a "Linear Optimization" model. Optimization is the process of selecting values of decision variables that minimize or maximize a quantity of interest. The objective function can be to maximize graduation rate where the decision variables are: applications received, applications accepted, new students' enrolled, part-time undergrads, out-of-state tuition and student/faculty ratio. Each higher education institution can identify the appropriate constraints and limitations for each of the decision variables. For example the lowest acceptable value for out-of-state or the highest ratio of student/faculty. Higher education institutions can find the right combination of decision variables that maximize their graduation rates.

Since graduation rates have come to reflect overall quality of higher education institutions and how effectively a campus delivers what students expect and need, future research can also focus on gathering more data from universities as well as validating the data obtained to make sure it is up to date and correct. Additionally, a different study could be done specifically focusing on the graduation rates of four-year institutions since multiple studies have already been conducted only on two-year colleges as noted in this paper's references. Then, research could be executed to compare the variables that impact four-year graduation rates to two-year rates. Furthermore, a comparison could be made between graduation rates in public versus private universities or certain schools, colleges. Future research can replicate the forecasting model at universities outside the United States of America. And finally, future research can investigate further the interaction between the independent variables and how the interaction might relate to graduation rates.

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