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A Study of Enrollment Projections for USA Higher Education Institutions

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Abstract

This study provides results from a survey on enrollment projections, methods, metrics, timing, and model among public 2-year and 4-year higher education institutions in the United States. The data are from 127 public, 4-year and 73 public, 2-year institutions surveyed in spring and summer 2021. The results are summarized on various aspects of the process for developing enrollment projection numbers from the factors considered, the type of enrollment models used, methods and modeling techniques implemented, and the involvement of campus offices. These findings will help provide details on current enrollment models, methods and modeling techniques implemented, and campus offices' involvement in enrollment projections in higher education institutions. The study reveals, there is no vast difference in how public, 4-year and public, 2-year institutions oversee enrollment projections. Almost all institutions build and develop their enrollment models in-house. The most widely used software for modeling and presenting enrollment projections is Microsoft (MS) Excel. The top three modeling techniques implemented in enrollment projection are Time series models, Markov chain models, and Linear regression models. Multiple offices in the institutions participate in the process of producing enrollment projection numbers.

Keywords: data mining techniques, enrollment models, modeling techniques, predictive modeling

1 Introduction

Given the current trend of declining enrollments in many higher education institutions, the importance of timely, accurate, flexible, and accessible enrollment projection models has risen dramatically. These enrollment projections are crucial for budgeting, course allocation, and overall resource allocation [1]. According to [2], "Planning for an uncertain future in the face of challenging economic conditions continues to be a priority for higher education administration."

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Often the motives for students attending a 2- vs 4- year institution differ (degree attainment, general education credit accumulation, etc.). Four-year institutions typically enroll more traditional students, whereas 2-year schools enroll more non-traditional students. For these reasons, the types of variables relevant to projecting enrollment vary by institution type.

Many different elements determine enrollment and must be considered in enrollment projection models. These include the type of data for analysis (cohort data by year/semester or individual student data), enrollment model focus (e.g., new undergraduate (UG) students, new transfer students, new graduate students, returning students, total enrollment), the factors/variables incorporated in the model (e.g., number of applicants, number of admits, historical numbers, i.e., enrollment, retention, and graduation), and the modeling methodology (e.g., Logistics Regression, Time Series, Markov Chain Model) [2].

Reference [3] discuss factors that affect enrollment by the category of personnel: "The economist might focus on the intersection of measured supply-and-demand curves. The demographer might focus on where students are located. For the higher education administrator, enrollment is determined by the combined effects of many manageable and unmanageable factors, categories that are roughly, though not completely, equivalent to supply and demand." They further classify factors affecting enrollment as demographic, economic, social, cultural, manageable, and unmanageable factors. Other factors that impact enrollment are population change, family income, parents' level of education, tuition, student aid levels, and student academic aptitude [4].

The goal of enrollment projections is to obtain a numerical value of the future enrollment of a group of students at the institution. According to [3], there are two approaches to achieving this goal – quantitative and qualitative. They define quantitative as curve-fitting techniques (trend analyses) and causal (explanatory, structural, econometric) models, and qualitative as involving consulting with a group of experts, securing their individual opinions, and trying to reach a consensus. However, many higher education institutions use a combination of quantitative and qualitative approaches in enrollment projections to arrive at the best enrollment estimate.

Historic enrollment data are typically analyzed to identify a pattern in past years' enrollment at the institution. This pattern is then extended to make future years' projections. The modeling techniques used to model this data type include curve fitting or trend analysis, causal modeling, and predictive modeling (machine learning methods and data mining techniques). Methodologies used in curve fitting or trend analysis are simple and moving averages, autoregressive moving average (for short-term forecasts and is particularly appropriate for addressing trends and repetitive seasonal patterns), and exponential smoothing (which gives more weight to recent values and is suitable for data that exhibit no apparent trends or seasonal patterns). Also, techniques used for causal modeling include regression analysis, where the dependent variable is the number of students (enrollment), and the independent (explanatory or predictor) variables are the factors that affect enrollment [4] [3] [5]. The machine learning methods and data mining techniques which include logistic regression (LR) and support vector machines (SVMs), decision trees, random forest, neural networks, naïve Bayesian method, etc., are utilized for enrollment prediction [6][7][8][1][9].

Reference [10] shows how three different models were used to predict enrollment. The first is a long-term aggregate university model where judgment-based estimated growth rates are used to predict enrollment levels by using historical and control factors for distributing growth. The second model is a short-term detailed university model, short-term predictions for headcount,

student credit hours, and the number of full-time equivalents at the university overall, as well as by level and classification. An embedded optimization model is used to fit the transition factors to improve the model's performance. The third model is an enhanced graduate student's prediction model by college. In this model, the Markov chain model captures the students' behavior by developing transition probabilities within the colleges.

Many offices and personnel engage in producing enrollment projections. These offices and personnel are from various institution divisions, including the Office of Institutional Research, Admissions, Enrollment and Retention, Budget and Finance, Academic Departments, etc. [3].

There are limited literatures about how institutions conduct enrollment projections in their institutions. This research addresses this issue by surveying individuals who work in offices (e.g., Institutional Research) that produce enrollment numbers to obtain details on the process and models implemented to arrive at the official projected enrollment numbers used for budgeting and other purposes. This paper presents the findings of an extensive survey on enrollment projection processes at higher education institutions in the United States of America. The survey questions fell into four categories: target (e.g., Headcount, SCH) and factors considered in enrollment projections, types of enrollment models used by institutions, methods and modeling techniques implemented in enrollment projection, and the campus offices involved in enrollment projection.

The remainder of this paper is organized as follows. Section 2 describes the methodology used in developing the survey under these topics: Survey Development, Format and Administration of Survey, Survey Administration and Participant Recruitment, Survey Respondents, and Data Analysis. Section 3 shows the results and discussion of the survey responses. Finally, Section 4 presents the Summary and Conclusions.

2 Methods

To describe the process involved in Enrollment Projections and the current projection models used by higher education institutions in the United States, we employed a mixed methods sequential explanatory design [11] with two approaches. Thus, a quantitative approach through the administration of a survey, followed by a qualitative approach of interviewing volunteer respondents to discuss in detail models currently used by their institutions.

2.1 Survey Development

The survey was developed in Fall 2020 and administered in Spring 2021. Questions on the survey were inspired by available literature/articles and authors' experience with the involvement in enrollment projections and higher education.

The survey was designed and formatted in Qualtrics. For face and content validity, we shared the survey with five pilot respondents who are directors/assistant directors in the Office of Institutional Research and are currently involved in enrollment projections at their institutions for their review. The reviewers were asked to give feedback regarding the structure and format of the survey, the inclusion and ordering of questions, length of the survey, clarity of questions and answer choices, and other factors or issues the study failed to address. Based on their feedback, we modified some questions and answer choices and added one question. Their feedback in-

cluded adjusting the online formatting, functionality, making minor edits for easy readability, and flow of the survey.

2.2 Format and Administration of Survey

The survey questions were designed with guidance from survey methodologists and the survey responses remain anonymous [12]. The survey was administered online as a single long page, with questions categorized into several sections. A Computer logic was used to filter questions that did not apply to certain participants [13]. The final survey is available with the first author.

To ensure the validity of the institution's responses, only respondents who are personally involved or have direct knowledge in the production of enrollment projections at their institutions were analyzed. Potential participants were asked if they were personally involved in producing enrollment projections at their institutions. For those responding "no," they were asked another question if they were familiar enough with the enrollment model to complete the survey. If yes, they advanced to the first question in the main study. If no, they were asked to direct to someone who could answer. If yes, they moved to a page to provide details on the contact person. If they indicated "no," the respondent was taken to a page that thanked them for their participation. In concluding the survey, participants were asked if they were willing to participate in a 15–30 minute discussion about the details of the models applied at their institution. If yes, the respondents were directed to the page to provide their details. If they indicated "no," they advanced to the last question on the survey.

2.3 Survey Administration and Participant Recruitment

The survey was implemented online via Qualtrics for three weeks in March-May 2021. Participants were not required to complete the survey in a single setting. Hence, an incomplete survey was saved for one week before being automatically submitted to Qualtrics. At the end of the survey, participants could enter their contact information to be included in a raffle for a $50 gift card (6 random names drawn). To ensure anonymity, the information collection about the raffle and main survey was done through links to separate survey forms and was not linked to survey responses.

The list of participating institutions was recruited from the Integrated Postsecondary Education Data System (IPEDS), making it a convenient and volunteer sample. All public, 4-year or above and public, 2-year institutions with 1000 or more total enrolled students in 2019/2020 academic year were recruited. The survey invitation was sent to emails collected from the institution's websites of vice presidents, directors, or contact persons from the Office of Institutional Research of the selected institutions. The survey was sent to approximately 1061 contacts.

2.4 Survey Respondents

A total of 230 respondents accessed the survey. Of those, 189 were personally involved in producing enrollment projections at their institutions. Of the 41 that were not, 28 were familiar enough with their enrollment model to answer the survey. Of the 12 that were not, two were able to direct us to the person who could complete the survey. Seventeen of the respondents that were either personally involved in the production of enrollment projections at their institutions or were familiar enough with the enrollment model used by their institutions did not respond to any of the remaining survey questions. Thus, the valid number of respondents varied on items from 0 to 200 due to attrition and skipping questions.

2.5 Data Analysis

Data were collected anonymously with no personal identifiers other than the information on the enrollment projection models used by the institutions. The survey data was exported from Qualtrics and imported into Statistical Package for the Social Sciences (SPSS) for data management and analysis. Some closed-ended questions with open-ended options (e.g., "Other") were recorded as an additional option to the closed-ended responses where applicable. For example, the Full-Time Equivalent Students (FTES) was added to the list of options for the question "What targets are the enrollment projections based on (select all that apply)?"). The questions were summarized using frequencies and percentages. For multiple-choice questions, the percentage of participants giving each response was computed. There is no formal hypothesis testing. The Institutional Review Board of Central Michigan University approved this study.

3 Results and Discussion

3.1 Institutions Demographics

Institution demographics (State, Sector of Institution, and Institution Size) data was obtained from IPEDS for Fall 2020. Survey respondents were from at least one institution in 44 states. Of the 200 institutions that responded, 21 (10.5%) were from California, 16 (8%) from New York, 13 (6.5%) from Texas, 10 (5%) from Michigan, and the distribution of the other states can be seen in Appendix, Table 18.

Of the 200 institutions that responded, 127 are 4-year or more, and 73 are 2-year institutions. Approximately 30% of the 4-year and above institutions have an institutional size of 10,000-19,999, 52% have less than 10,000, and 18.9% have 20,000 or more students. The majority (43.8%) of the 2-year institutions come from institutions with 1,000-4,999 students, 37% with 5,000-9,999 students, 16.4% with 10,000-19,999 student and 2 (2.7%) institutions with 20,000 or more enrolled students in Fall 2020 (Table 1).

3.2 Differences Between Two-Year Vs Four-Year Schools

Often the motives for students attending 2- vs 4-year institutions differ (degree attainment, general education credit accumulation, etc.); therefore, it is appropriate to assume that there is a difference in how both types of institutions oversee enrollment. Hence, the results and discussion from the survey are presented between public, 4-year or more and public, 2-year institutions. The survey questions are categorized into four sections: Enrollment Projections, Enrollment Models, Methods and Modeling Techniques Implemented in Enrollment Projection, and Campus Office Involvement in Enrollment Projection.

Table 1: Sector of Institution by Institutional Size by Category

	Institution Size Category	
	1,000 - 4,999	5,000 - 9,999
Sector of Institution	n (%)	n (%)
Public, 4-year	33 (26.0%)	33 (26.0%)
Public, 2-year	32 (43.8%)	27 (37.0%)
Total	65 (32.5%)	60 (30.0%)

[a] IPEDS-Fall 2020

3.2.1 Enrollment Projections

An institution can have multiple enrollment projections, and the target of the forecast defines it. Once the target is specified, the factors that impact/affect the target are identified. Independent of the institution sector, the vast majority (87.4% of 4-year vs 71.2% of 2-year) of institutions produce headcount projections, and about 41% of 4-year and 2-year institutions make student Credit Hours (SCH) projections. Other enrollment projection targets are student contact hours and billing units (Table 2). There is much similarity in 2- and 4-year institutions regarding what projections are based on.

Table 19 in Appendix shows the distribution of the factors incorporated in the enrollment models used by the institution among 4-year and 2-year institutions. Factors included by at least 50% of 4-year institutions are historic enrollment numbers (76.4%), Historic Graduation Numbers/Rates (55.9%), Historic Retention Numbers/Rates (71.7%), and Number of Admits (52%). Whereas factors incorporated by at least 30% of the public, 2-year institutions are Economic Factors (e.g., BLS Statistics, Unemployment statistics, etc.) (30.1%), Population Growth Projections (31.5%), High School Enrollment Projections from the State (35.6%), Historic Enrollment Numbers (68.5%), Historic Graduation Numbers/Rates (35.6%), Historic Retention Numbers/Rates (60.3%), Number of Applicants (35.6%).

Table 2: What targets enrollment projections is based on?

	Public, 4-year	Public, 2-year
	n (%)	n (%)
Headcounts	111 (87.4%)	52 (71.2%)
Student Credit Hours (SCH)	52 (40.9%)	30 (41.1%)
Fiscal Year Equated Students (FYES)	23 (18.1%)	15 (20.5%)
Full-Time Equivalent Students (FTES)	8 (6.3%)	6 (8.2%)
Other	1 (0.8%)	2 (2.7%)

[a] Respondents could select all that apply

3.2.2 Enrollment Models

Institutions may implement one or more enrollment models for their institution's different student admission categories. Participants were asked to select all the enrollment models by admission category used at the institution. The majority (86.6% public,4-year, or above vs 60.3% public, 2-year) of institutions have a new UG First year student enrollment model. About 51% of public, 2-year institutions have an enrollment model for high School Students compared to 19% of public, 4-year institutions. 15.7% public,4-year, or above vs 34.2% public, 2-year institutions have ONLY Total Enrollment Model for both new and current students (Figure 1).

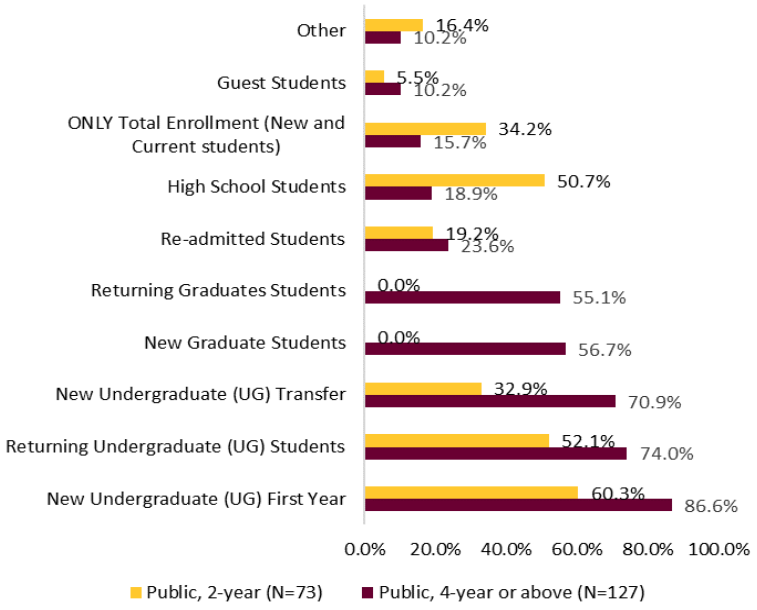

Figure 1: Percentage of institutions in public,4-year or above (n=127) regarding enrollment models used at institution, compared to public, 2-year (n=73)
*Respondents could select all that apply

Regarding the total number of enrollment models by admission categories used by an institution, about 85% of 4-year institutions have more than one enrollment model compared to 65% of 2-year institutions. The modal number of models is five for 4-year and one for 2-year institutions. It makes sense as 2-year institutions have fewer student types to project. (Table 3).

Table 3: Total number of Enrollment Models by institution

	Public, 4-year	Public, 2-year
Number of Models	n (%)	n (%)
1	19 (15%)	25 (34.2%)
2	14 (11%)	12 (16.4%)
3	18 (14.2%)	14 (19.2%)
4	7 (5.5%)	7 (9.6%)
5	34 (26.8%)	12 (16.4%)
6	16 (12.6%)	2 (2.7%)
7	11 (8.7%)	1 (1.4%)
8	8 (6.3%)	0 (0%)
Mean	4.22	2.71
Median	5	2
Mode	5	1

The data in Table 4 show that 2- and 4- year institutions tend to start their enrollment projection 7-12 months before the start of term.

Table 4: How many months prior to the enrollment term the models are initiated?

		1-6 Months	7-12 Months
		n (%)	n (%)
Public, 4-year or above	FTIAC	25 (31.3%)	55 (68.8%)
	Transfer	20 (30.8%)	45 (69.2%)
	Returning UG	23 (35.9%)	41 (64.1%)
	New GR	17 (34%)	33 (66%)
	Returning GR	17 (36.2%)	30 (63.8%)
	Total Enrolled	6 (35.3%)	11 (64.7%)
	Re-admits	9 (45%)	11 (55%)
	Guest	11 (68.8%)	5 (31.3%)
	HS	3 (23.1%)	10 (76.9%)
Public, 2-year	FTIAC	11 (35.5%)	20 (64.5%)
	Transfer	10 (50%)	10 (50%)
	Returning UG	13 (43.3%)	17 (56.7%)
	New GR	0 (0%)	0 (0%)
	Returning GR	0 (0%)	0 (0%)
	Total Enrolled	11 (55%)	9 (45%)
	Re-admits	4 (33.3%)	8 (66.7%)
	Guest	4 (50%)	4 (50%)
	HS	14 (53.8%)	12 (46.2%)

The following Table 5 provides the abbreviations used in Tables 6-9

Table 5: Abbreviations

Abbreviations	**Word**
FTIAC	New Undergraduate (UG) First Year
Transfer	New Undergraduate (UG) Transfer
Returning UG	Returning Undergraduate (UG) Students
New GR	New Graduate Students
Returning GR	Returning Graduates Students
Total Enrolled	ONLY Total Enrollment (New and Current students)
Re-admits	Re-admitted Students
Guest	Guest Students
HS	High School Students

As seen in Table 6 both 2- and 4-year institutions tend to update and share their enrollment model projections as needed/when the opportunity arises. Very few institutions update forecasts daily.

Table 6: How frequently model projections are updated and shared?

	Daily	Weekly	Monthly	Quarterly	Semi-Annually	Other	Never	As Needed
Public, 4-year								
FTIAC	4 (3.8%)	16 (15.2%)	14 (13.3%)	10 (9.5%)	17 (16.2%)	7 (6.7%)	4 (3.8%)	33 (31.4%)
Transfer	3 (3.4%)	9 (10.3%)	13 (14.9%)	9 (10.3%)	14 (16.1%)	8 (9.2%)	4 (4.6%)	27 (31%)
Returning UG	2 (2.2%)	10 (11%)	9 (9.9%)	8 (8.8%)	22 (24.2%)	7 (7.7%)	5 (5.5%)	28 (30.8%)
New GR	2 (2.9%)	8 (11.4%)	8 (11.4%)	8 (11.4%)	13 (18.6%)	8 (11.4%)	4 (5.7%)	19 (27.1%)
Returning GR	1 (1.5%)	6 (8.8%)	9 (13.2%)	8 (11.8%)	16 (23.5%)	8 (11.8%)	5 (7.4%)	15 (22.1%)
Total Enrolled	1 (5.6%)	4 (22.2%)	1 (5.6%)	1 (5.6%)	1 (5.6%)	1 (5.6%)	1 (5.6%)	8 (44.4%)
Re-admits	1 (3.6%)	4 (14.3%)	5 (17.9%)	4 (14.3%)	2 (7.1%)	2 (7.1%)	2 (7.1%)	8 (28.6%)
Guest	1 (9.1%)	2 (18.2%)	0%	2 (18.2%)	2 (18.2%)	1 (9.1%)	1 (9.1%)	2 (18.2%)
HS	1 (4.8%)	2 (9.5%)	1 (4.8%)	3 (14.3%)	3 (14.3%)	2 (9.5%)	1 (4.8%)	8 (38.1%)
Other	0%	1 (8.3%)	1 (8.3%)	1 (8.3%)	1 (8.3%)	2 (16.7%)	0%	6 (50%)
Public, 2-year								
FTIAC	1 (2.5%)	5 (12.5%)	4 (10%)	2 (5%)	9 (22.5%)	1 (2.5%)	1 (2.5%)	17 (42.5%)
Transfer	0%	4 (17.4%)	2 (8.7%)	1 (4.3%)	4 (17.4%)	1 (4.3%)	0%	11 (47.8%)
Returning UG	1 (2.8%)	5 (13.9%)	4 (11.1%)	4 (11.1%)	7 (19.4%)	1 (2.8%)	0%	14 (38.9%)
Total Enrolled	3 (13%)	2 (8.7%)	2 (8.7%)	1 (4.3%)	6 (26.1%)	1 (4.3%)	0%	8 (34.8%)
Re-admits	1 (7.7%)	0%	1 (7.7%)	1 (7.7%)	3 (23.1%)	1 (7.7%)	0%	6 (46.2%)
Guest	0%	1 (25%)	0%	0%	2 (50%)	0%	0%	1 (25%)
HS	1 (2.9%)	5 (14.7%)	1 (2.9%)	3 (8.8%)	9 (26.5%)	2 (5.9%)	0%	13 (38.2%)
Other	0%	0%	0%	0%	2 (22.2%)	0%	2 (22.2%)	5 (55.6%)

Table 7: How data for the enrollment model is updated?

Sector	Enrollment Model	Automatic – updates populated from data source automatically n (%)	Manual – updates extracted from data source and entered by hand n (%)	Both n (%)
Public, 4-year or above	FTIAC	21 (20.4%)	53 (51.5%)	29 (28.2%)
	Transfer	17 (20%)	41 (48.2%)	27 (31.8%)
	Returning UG	21 (23.3%)	41 (45.6%)	28 (31.1%)
	New GR	13 (18.8%)	31 (44.9%)	25 (36.2%)
	Returning GR	16 (23.9%)	26 (38.8%)	25 (37.3%)
	Total Enrolled	5 (27.8%)	11 (61.1%)	2 (11.1%)
	Re-admits	9 (32.1%)	13 (46.4%)	6 (21.4%)
	Guest	3 (27.3%)	5 (45.5%)	3 (27.3%)
	HS	6 (28.6%)	11 (52.4%)	4 (19%)
	Other	2 (15.4%)	8 (61.5%)	3 (23.1%)
Public, 2-year	FTIAC	3 (7.9%)	20 (52.6%)	15 (39.5%)
	Transfer	3 (13%)	12 (52.2%)	8 (34.8%)
	Returning UG	4 (11.1%)	18 (50%)	14 (38.9%)
	New GR	(0%)	(0%)	(0%)
	Returning GR	(0%)	(0%)	(0%)
	Total Enrolled	3 (13%)	13 (56.5%)	7 (30.4%)

Re-admits	3 (23.1%)	6 (46.2%)	4 (30.8%)
Guest	(0%)	2 (50%)	2 (50%)
HS	3 (8.8%)	22 (64.7%)	9 (26.5%)
Other	(0%)	4 (57.1%)	3 (42.9%)

Most institutions update data for their enrollment models manually (Table 7).

Most 4-year and 2-year institutions update the parameters of their enrollment models once initiated as needed/when an opportunity arises. Among the 4-year institutions, a decent number never update their models. They are ignoring various new pieces of information that may become available such as applications and admit numbers, etc. Hence, they are using static models (Table 8).

Table 8: How often the enrollment model parameters are updated once the model is initiated?

	Never	Weekly	Monthly	Quarterly	Semi-Annually	Annually	Other	As Needed
Public, 4-year								
FTIAC	12 (12%)	3 (3%)	2 (2%)	4 (4%)	6 (6%)	25 (25%)	4 (4%)	44 (44%)
Transfer	9 (10.8%)	3 (3.6%)	2 (2.4%)	4 (4.8%)	6 (7.2%)	19 (22.9%)	3 (3.6%)	37 (44.6%)
Returning UG	9 (10.1%)	2 (2.2%)	2 (2.2%)	3 (3.4%)	6 (6.7%)	24 (27%)	4 (4.5%)	39 (43.8%)
New GR	8 (11.8%)	3 (4.4%)	0%	2 (2.9%)	5 (7.4%)	17 (25%)	3 (4.4%)	30 (44.1%)
Returning GR	7 (10.6%)	2 (3%)	1 (1.5%)	2 (3%)	5 (7.6%)	19 (28.8%)	3 (4.5%)	27 (40.9%)
Total Enrolled	3 (16.7%)	0%	0%	0%	1 (5.6%)	3 (16.7%)	0%	11 (61.1%)
Re-admits	3 (10.7%)	2 (7.1%)	1 (3.6%)	3 (10.7%)	1 (3.6%)	2 (7.1%)	1 (3.6%)	15 (53.6%)
Guest	2 (18.2%)	1 (9.1%)	0%	1 (9.1%)	2 (18.2%)	1 (9.1%)	1 (9.1%)	3 (27.3%)
HS	2 (10%)	0%	1 (5%)	1 (5%)	2 (10%)	3 (15%)	1 (5%)	10 (50%)
Other	1 (7.7%)	0%	1 (7.7%)	1 (7.7%)	1 (7.7%)	1 (7.7%)	1 (7.7%)	7 (53.8%)
Public, 2-year								
FTIAC	1 (2.8%)	0%	2 (5.6%)	0%	3 (8.3%)	13 (36.1%)	0%	17 (47.2%)
Transfer	1 (4.5%)	0%	2 (9.1%)	0%	2 (9.1%)	7 (31.8%)	0%	10 (45.5%)
Returning UG	2 (5.9%)	0%	2 (5.9%)	0%	2 (5.9%)	12 (35.3%)	0%	16 (47.1%)
Total Enrolled	1 (4.3%)	2 (8.7%)	1 (4.3%)	0%	1 (4.3%)	4 (17.4%)	2 (8.7%)	12 (52.2%)
Re-admits	0%	0%	1 (7.7%)	0%	2 (15.4%)	4 (30.8%)	0%	6 (46.2%)
Guest	0%	0%	0%	0%	0%	3 (75%)	0%	1 (25%)
HS	1 (3.1%)	1 (3.1%)	1 (3.1%)	0%	1 (3.1%)	13 (40.6%)	0%	15 (46.9%)
Other	2 (22.2%)	0%	0%	0%	0%	2 (22.2%)	0%	5 (55.6%)

Table 9: How are the model parameters updated?

		Automatic	Manual	Both
Sector	Enrollment Model	n (%)	n (%)	n (%)
Public, 4-year or above	FTIAC	15 (15.3%)	49 (50%)	34 (34.7%)
	Transfer	11 (13.6%)	42 (51.9%)	28 (34.6%)
	Returning UG	15 (17.2%)	41 (47.1%)	31 (35.6%)
	New GR	9 (13.6%)	33 (50%)	24 (36.4%)
	Returning GR	12 (18.8%)	28 (43.8%)	24 (37.5%)
	Total Enrolled	4 (22.2%)	10 (55.6%)	4 (22.2%)
	Re-admits	6 (22.2%)	14 (51.9%)	7 (25.9%)
	Guest	2 (20%)	5 (50%)	3 (30%)

	HS	3 (15.8%)	11 (57.9%)	5 (26.3%)
	Other	3 (23.1%)	7 (53.8%)	3 (23.1%)
Public, 2-year	FTIAC	2 (5.7%)	23 (65.7%)	10 (28.6%)
	Transfer	2 (9.1%)	14 (63.6%)	6 (27.3%)
	Returning UG	3 (8.8%)	22 (64.7%)	9 (26.5%)
	Total Enrolled	2 (8.7%)	14 (60.9%)	7 (30.4%)
	Re-admits	2 (15.4%)	10 (76.9%)	1 (7.7%)
	Guest	(0%)	3 (75%)	1 (25%)
	HS	2 (6.5%)	24 (77.4%)	5 (16.1%)
	Other	(0%)	6 (85.7%)	1 (14.3%)

Most 4-year and 2-year institutions manually update their enrollment model parameters (Table 9). Participants were asked to select all the enrollment models by type of students used at the institution (Table 10). 44.1% vs 53.4% of public, 4-year and public, 2-year respectively have only one model for all students. The distinct types of student enrollment models used by public, 4-year institutions are Grad/Undergrad (44.9%), Total Student Enrollment for the Institution (43.3%), In-state Students (34.6%), Out-of-State Students (33.1%) and among public, 2-year institutions are Total Student Enrollment for the Institution (31.5%), Full-time Students (23.3%), Part-time Students (21.9%). Very few institutions have enrollment models by course delivery type. Discussions from the interview sessions reveal that most schools have one overall model, populated by separate models for each student category implemented by the institution. For some institutions, the new first-year students (freshman and transfer) are modeled. While for other institutions, the projected number is provided by their admission or the student enrollment office to be inputted into the Total overall model.

Table 10: The separate enrollment models used by the institution

	Public, 4-year	Public, 2-year
	n (%)	n (%)
Grad/Undergrad	57 (44.9%)	1 (1.4%)
One model for all Students	56 (44.1%)	39 (53.4%)
Total Student Enrollment for the Institution	55 (43.3%)	23 (31.5%)
In-state Students	44 (34.6%)	5 (6.8%)
Out-of-State Students	42 (33.1%)	4 (5.5%)
Full-time Students	36 (28.3%)	17 (23.3%)
Total Student Enrollment by College	31 (24.4%)	5 (6.8%)
Part-time Students	29 (22.8%)	16 (21.9%)
Total Student Enrollment by Program/Department	23 (18.1%)	8 (11%)
Course delivery type (online)	16 (12.6%)	7 (9.6%)
Upper Division/Lower Division	12 (9.4%)	(0%)
Course delivery type (face to face)	11 (8.7%)	7 (9.6%)
Non-traditional Students	7 (5.5%)	
Other	5 (3.9%)	6 (8.2%)
Online admits vs face to face admits	2 (1.6%)	(0%)
In-district Students	1 (0.8%)	7 (9.6%)

Out-district Students	1 (0.8%)	7 (9.6%)

[a] Respondents could select all that apply

3.3 Methods and Modeling Techniques Implemented in Enrollment Projection

Institutions were accessed on the approach employed in developing enrollment models, the statistical methodologies and software used by institutions in developing and presenting enrollment projections.

Table 11: Which approach do the enrollment projection models employ?

	Public, 4-year	Public, 2-year
	n (%)	n (%)
Combined Approach	59 (50.9%)	34 (57.6%)
Quantitative Approach	54 (46.6%)	22 (37.3%)
Qualitative Approach	3 (2.6%)	3 (5.1%)

Over 50% of both 4-year and 2-year institutions use a combined quantitative and qualitative approach in building their enrollment projection models. Very few institutions (2.6% 4-year and 5.1% 2-year) employ only the qualitative approach in the development of their enrollment models (Table 11).

In accessing the sampling units used in building the enrollment models used by institutions, approximately 60% of both 4-year and 2-year institutions use cohort/aggregate data in building their enrollment models, while almost 25% use both individual student record data and cohort data in building their enrollment models (Table 12).

Table 12: What sampling unit is used in building the enrollment models?

	Public, 4-year	Public, 2-year
	n (%)	n (%)
Cohort data/Aggregate data (e.g., Semester, yearly)	68 (60.2%)	35 (60.3%)
Both (Individual students and cohort)	27 (23.9%)	15 (25.9%)
Individual student data	18 (15.9%)	8 (13.8%)

Table 13: What methodology is implemented for the enrollment projection?

	Public, 4-year	Public, 2-year
	n (%)	n (%)
Time Series	54 (42.5%)	23 (31.5%)
Markov Chain Model	37 (29.1%)	13 (17.8%)
Linear Regression Model	32 (25.2%)	30 (41.1%)
Logistics Regression	24 (18.9%)	10 (13.7%)
A distributional weighting Model	19 (15%)	8 (11%)
Algebraic Model	15 (11.8%)	6 (8.2%)
Rule-Based prediction models	5 (3.9%)	4 (5.5%)

Random Forest	3 (2.4%)	(0%)
Bayesian Networks	2 (1.6%)	1 (1.4%)
Simulation Models	2 (1.6%)	2 (2.7%)
Poisson Regression (Predicting total count)	1 (0.8%)	3 (4.1%)
Neural Networks	1 (0.8%)	(0%)
Others	1 (0.8%)	1 (1.4%)
Support Vector Machines (SVM)	(0%)	1 (1.4%)

[a] Respondents could select all that apply

Respondents were asked to indicate what methodology is implemented for their enrollment models. The top 4 models implemented by 4-year and 2-year institutions, respectively are: Time series models (42.5% vs 31.5%), Markov Chain models (29.1% vs 17.8%), Linear Regression Models (25.2% vs 41.1%), and Logistic Regression (18.9% vs 13.7%). The interview sessions reveal that most institutions use trend analysis, thus making future enrollment predictions based on historical enrollment data. This leads to some institutions classifying their enrollment models as Time Series (Table 13).

Table 14: What software is used to develop the enrollment models?

	Public, 4-year	Public, 2-year
	n (%)	n (%)
MS Excel	74 (58.3%)	38 (52.1%)
SAS	27 (21.3%)	6 (8.2%)
SPSS	23 (18.1%)	16 (21.9%)
Other	22 (17.3%)	9 (12.3%)
R/RStudio	14 (11%)	9 (12.3%)
Rapid Insight	7 (5.5%)	2 (2.7%)
Python	3 (2.4%)	1 (1.4%)
SQL	3 (2.4%)	1 (1.4%)
Power BI	3 (2.4%)	(0%)
STATA	2 (1.6%)	1 (1.4%)
Tableau Prep	1 (0.8%)	1 (1.4%)
JMP	(0%)	1 (1.4%)

[a] Respondents could select all that apply.

To determine the software used to develop their enrollment models, participants were asked, "What software is used to develop the enrollment models?". The top 3 software used by 4-year institutions are: MS Excel (58.3%), SAS (21.3%), SPSS (18.1%) and 2-year institutions are MS Excel (52.1%), SPSS (21.9%), R/RStudio (12.3%). In Table 11, most institutions use cohort data which is easily manipulated in MS Excel, and most institutions build their enrollment models in MS Excel (Table 14).

Regarding how institutions present enrollment projection models, participants were asked "What software is used to present the enrollment models?". The top 3 software used by public, 4-year and public, 2-year institutions are: MS Excel (70.9% vs 56.2%), Pdf (15.7% vs 17.8%), and Tableau (12.6% vs 16.4%). Other software used are Anaplan, IBM, Cognos, MS Word, PowerPoint, STATA, SAS Viya, Veera Predict by public, 4-year institutions and Blackboard Analytics, Infomaker reports, MS word, MS PowerPoint, Rapid Insight Veera Construct and Veera Bridge by public, 2-year institutions (Table 15).

Table 15: What software is used to develop the enrollment models?

	Public, 4-year	Public, 2-year
	n (%)	n (%)
MS Excel	90 (70.9%)	41 (56.2%)
Pdf	20 (15.7%)	13 (17.8%)
Tableau	16 (12.6%)	12 (16.4%)
Other	12 (9.4%)	7 (9.6%)
Power BI	9 (7.1%)	11 (15.1%)
HTML	4 (3.1%)	(0%)
R Shinny	1 (0.8%)	1 (1.4%)

[a] Respondents could select all that apply

Table 16: How are the enrollment projection models built?

	Public, 4-year	Public, 2-year
	n (%)	n (%)
In House	98 (90.7%)	54 (91.5%)
External firm (e.g., Hired Consultancy firms)	1 (0.9%)	0 (0%)
Both (In House and External Firm)	8 (7.4%)	4 (6.8%)
Other	1 (0.9%)	1 (1.7%)

The majority of over 90% of public, 4-year and public, 2-year institutions build their enrollment projection models in-house. A few institutions (7.4% public, 4-year vs 6.8% pubic, 2-year) build their enrollment models in-house and use external firms (Table 16).

3.4 Campus Offices Involvement in Enrollment Projection

Enrollment projection involves consulting with relevant groups on campus, sharing enrollment model methodology, and enrollment projections with multiple offices, individuals, or divisions. The top 5 offices consulted by 4-year institutions are Admissions/Student Enrollment Office (73.2%), Budgetary Office (37.8%), Provost Office (30.7%), Financial Aid Office (26%), Deans and Department Chairs (20.5%). The Registrar's Office, office of Strategic Initiatives, Administrative Affairs, Graduate Schools, and the office of Student Success are also consulted. The top 5 offices consulted by 2-year institutions are Admissions/Student Enrollment Office (47.9%), Budgetary Office (30.1%), Financial Aid Office (24.7%), Deans and Department Chairs (23.3%), No One except your Office (e.g., Office of Institutional Research (IR)) (20.5%). Other offices

consulted are the President's Office and Institutional Research. These are similar for both 2- and 4-year institutions (Figure 2).

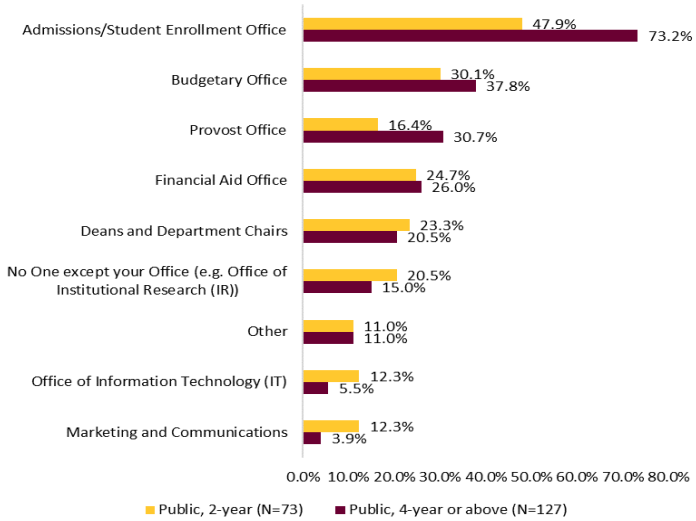

Figure 2: Percentage of institutions in public,4-year or above (n=127) regarding Which offices, individuals or parties are consulted and/or provide information used in the enrollment projection models? compared to public, 2-year (n=73)
*Respondents could select all that apply

Regarding whom enrollment projection numbers are shared (Figure 3), over 60% of 4-year institutions share the enrollment numbers with the President and Provost offices, Senior Leadership (Cabinets, etc.), Budget office, and Admission/Student Enrollment office. Other offices/individuals are the entire campuses, graduate school, governance groups, and state system offices. Whereas among 2-year institutions, 75.3% share the enrollment projection numbers with Senior Leadership (Presidents Cabinets, etc.), 68.5% share with the President and Provost office, and 52.1% share with the Budget office. The enrollment numbers are also shared with the entire campus. About 40% of public, 2-year institutions share their enrollment projection numbers with their Governing Board (e.g., Board of Trustees, Board of Regents, etc.) compared to 13.4% within public, 4-year or more institutions.

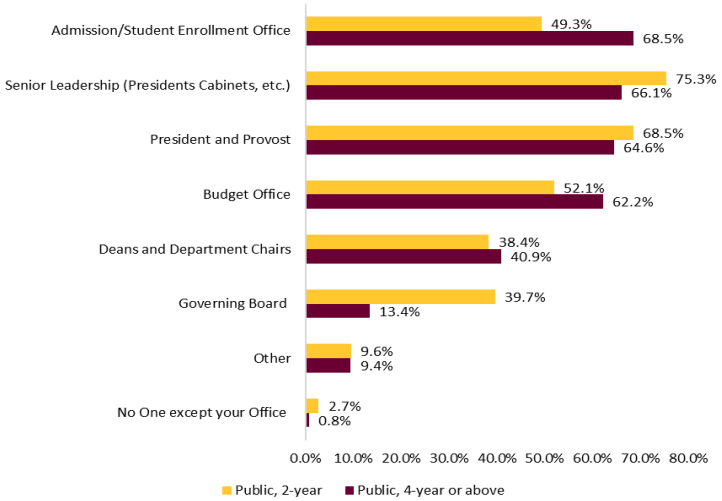

Figure 3: Percentage of institutions in public,4-year or above (n=127) regarding To whom are the enrollment projection numbers shared? compared to public, 2-year (n=73) *Respondents could select all that apply

Regarding whom the details of the projection model are shared (Figure 4), among the 4-year institutions, the majority (52%) share the details of the projection model with the Admission/Student Enrollment Office. And 40% or above share these details with the Budget office, President and Provost, and Senior Leadership (presidents Cabinets, etc.). Very few (3.9%) share the enrollment model details with their Governing Board (e.g., Board of Trustees, Board of Regents, etc.). Whereas among the 2-year institutions, the majority (47.9%) share the details of the projection model with their Senior Leadership (president's Cabinets, etc.). Other offices the details are shared with are the office of the President and Provost (45.2%), Budget office (32.9%), and Admission/Student Enrollment office (30.1%). Some institutions share the details with anyone who requests it. Institutions are less likely to share details of models than actual model projections.

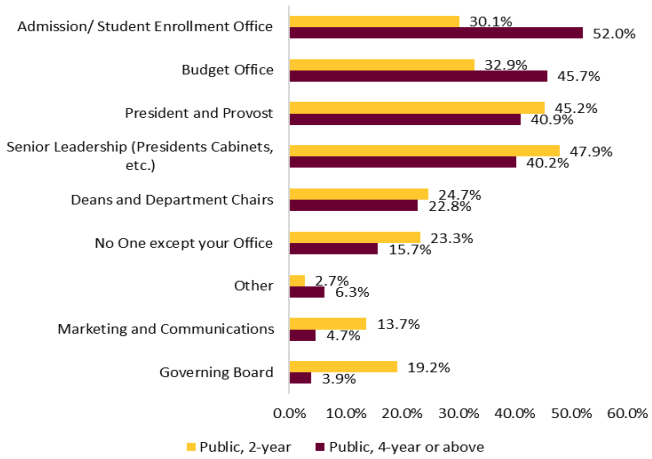

Figure 4: Percentages of institutions in public,4-year or above (n=127) regarding to whom are the details of the projection model shared? compared to public, 2-year (n=73) *Respondents could select all that apply

Of the participants that share the details of their projection models, 68.5% share with at most 3 offices. The majority (31.1% vs 32.12%) of 4-year and 2-year share with only one campus office. 20.8% of 4-year institutions share model details with two offices while 19.6% of 2-year institutions share details with three offices. Few (5.7%) of 4-year institutions share the models' details with at least six offices, compared to 14.3% among 2-year institutions (Table 17).

Table 17: Number of Offices details of the projection model is shared

	Public, 4-year	Public, 2-year
	n (%)	n (%)
1	33 (31.1%)	18 (32.1%)
2	22 (20.8%)	7 (12.5%)
3	20 (18.9%)	11 (19.6%)
4	12 (11.3%)	7 (12.5%)
5	13 (12.3%)	5 (8.9%)
6	5 (4.7%)	3 (5.4%)
7	1 (0.9%)	3 (5.4%)
8	0 (0%)	2 (3.6%)
Mean	2.71	3.09
Median	2	3
Mode	1	1

4 Summary and Conclusions

This study addresses the scope, timing, methodology, updating, and sharing of enrollment projection models at public, 4-year or more and public 2-year institutions. The findings reported here provide a useful snapshot of the different enrollment projections employed by higher education institutions. The methodologies and modelling techniques used in developing and implementing enrollment models in the institutions. And finally, the campus offices/divisions involved in the process and dissemination of enrollment projections.

4.1 Summary

The survey report represents findings from a convenient and volunteered sample of 200 public higher education institutions involved in the production of enrollment forecasting from both 4-year (n = 127) and 2-year (n = 73) institutions from 44 states in the US. The survey was administered to 1061, 4-year and 2-year institutions from all 50 states in the United States of America. Forty-eight percent of the 4-year institutions have at least 10,000 total enrolled students and eighty-one percent of 2-year institutions enrolled less than 10,000 in fall 2020 (IPEDS).

As expected, most 2- and 4-year institutions project headcounts and student credit hours (SCH). Most of the 4-year and 2-year institutions incorporated in their models' factors which includes Historic Enrollment Numbers, Historic Graduation Numbers/Rates, Historic Retention Numbers/Rates, and Number of Applicants. Factors incorporated by most 4-year institutions are Number of Admits. Whereas factors incorporated by many 2-year institutions are: Economic Factors (e.g., BLS Statistics, Unemployment statistics, etc.), Population Growth Projections, and High School Enrollment Projections from the State.

More than half of both 4-year and 2-year institutions have enrollment projection models by admission category for New Undergraduate First year and Returning Undergraduate Students. On the other hand, among 4-year institutions, more than half have enrollment projection models by admission category for new undergraduate transfers, new graduate students, and returning graduate students. Whereas among 2-year institutions, more than half have enrollment projection models by admission category for High School Students. 4-year institutions have on average five enrollment models by admission category and 2-year institutions have three enrollment models by admission category.

Majority of all institutions initiate their enrollment models 7-12 months prior to the enrollment term for all admission categories except for the guest students' model, which is initiated by most 4-year institutions in 1-6 months prior to the start term and the models for ONLY Total Enrollment and High School Students is initiated by most 2-year institutions in 1-6 months prior to the start term. Model projections are updated and shared in most institutions as and when needed or when the opportunity arises. The data used for the enrollment models and the model parameters are updated by majority of institutions manually. Also, the enrollment model parameters are updated as and when needed once the model is initiated.

Among 2-year and 4-year institutions, the most used enrollment model is one model for all students which is populated by the separate models for each student category implemented by the institution. Some 4-year institutions also tend to have graduate/undergraduate models or a model for Total Students Enrollment for the Institution. In addition, some 4-year institutions model in state and out of state students separately.

A quantitative and/or qualitative approach is employed by most institutions in building enrollment projection models. The mathematical or statistical models are built using historical data and to conclude on the projection numbers, the inputs from other offices/department chairs are taken into consideration and the models altered accordingly as and when needed. Most institutions build their enrollment models using cohort/Aggregate data (e.g., Semester, yearly).

Nearly all institutions build their enrollment projection models in house. The top 3 methodologies implemented by both type of institution for their enrollment projection are: Time Series (forecasting using past enrollment data), Markov Chain Model (using current data to predict next year), and Linear Regression Model (Predicting total count). More than half of 4-year and 2-year institutions develop their enrollment models using MS Excel. Other statistical software used by 4-year institutions are SAS and SPSS, and 2-year institutions are SPSS and R/RStudio. The enrollment projection numbers are presented by most institutions using MS Excel.

In developing enrollment projection models, majority of 4-year institutions consult with the Admissions/Student Enrollment office. Other offices consulted with are Budgetary office and Provost office. Also, among 2-year institutions almost half consult with the Admissions/Student Enrollment office and thirty percent consult with their Budgetary office. Most 4-year institutions share enrollment projection numbers with: Admission/Student Enrollment office, Senior Leadership (Presidents Cabinets, etc.), Senior Leadership (Presidents Cabinets, etc.), and Budget office. About forty percent also share with their Deans and Department Chairs. Whereas among the 2-year institutions the majority share the enrollment projection numbers with Senior Leadership (Presidents Cabinets, etc.) and close to half or more share with President and Provost, Budget Office, and Admission/Student Enrollment office. The top four offices or individuals who the details of the projection models are shared with are the same for both 4-year and 2-year

institutions. These are the Admission/ Student Enrollment office, President and Provost, Senior Leadership (Presidents Cabinets, etc.). The median number of offices model projection details are shared with are two and three among 4-year and 2-year institutions, respectively.

4.2 Conclusion

In conclusion, there is no vast difference in how public, 4-year or more institutions oversee enrollment projection from public, 2-year institutions. Most institutions have headcount enrollment projections, and a fair number also have student credit hours (SCH) projection models. Historic enrollment numbers, historic graduation numbers/rates, and historic retention numbers/rates are common factors used by both 2-year and 4-year or more institutions in developing their enrollment models. Two-year institutions have an average of three enrollment models by admission category whereas, 4-year institutions have an average of five enrollment models by admission category. Most institutions update the data for the enrollment models and the model parameters manually, and few institutions update manually and automatically. The projection numbers are updated and shared as needed by the institutions. Also, institutions employ both quantitative and qualitative approaches when building their enrollment projection models.

The most widely used software for modeling and presenting enrollment projections is MS Excel. The 2- and 4-year schools vary on the factors used in their enrollment projections (economics, jobs, at 2-year, etc.). However, both groups of institutions rely on similar modeling techniques and software when developing enrollment projection. The times when enrollment projection is initiated and who the model information is shared with are also identical between the institutions. Most institutions model their enrollment projections using Cohort data, the modeling techniques applied are similar among 2-year and 4-year institutions. Most institutions have one overall model, which is populated by the separate models for each student category implemented by the institution. For some institutions, the new first-year students are modeled using cohort data or individual student records. And for other institutions, the projected number is provided by the admission or enrollment office to be inputted into the Total overall model. Most institutions enrollment models are built and developed in-house. Multiple offices in the institutions participate in the process of producing enrollment projection numbers.

Appendix

Table 18: Distribution of number of Institutions responses by States (N=200)

State	Count	%	State	Count	%
California	21	10.5%	Kansas	3	1.5%
New York	16	8.0%	North Dakota	3	1.5%
Illinois	13	6.5%	New Mexico	3	1.5%
Texas	12	6.0%	Oregon	3	1.5%
Michigan	10	5.0%	Wisconsin	3	1.5%
North Carolina	9	4.5%	Wyoming	3	1.5%
Georgia	8	4.0%	Mississippi	2	1.0%
Pennsylvania	8	4.0%	Oklahoma	2	1.0%
Massachusetts	6	3.0%	South Carolina	2	1.0%

Maryland	6	3.0%	South Dakota	2	1.0%
Virginia	6	3.0%	Washington	2	1.0%
Alabama	5	2.5%	Alaska	1	0.5%
Arkansas	5	2.5%	Arizona	1	0.5%
Louisiana	5	2.5%	Delaware	1	0.5%
Ohio	5	2.5%	Iowa	1	0.5%
Colorado	4	2.0%	Kentucky	1	0.5%
Indiana	4	2.0%	Northern Marianas	1	0.5%
Minnesota	4	2.0%	Nebraska	1	0.5%
Missouri	4	2.0%	New Hampshire	1	0.5%
Tennessee	4	2.0%	New Jersey	1	0.5%
Florida	3	1.5%	Utah	1	0.5%
Idaho	3	1.5%	Vermont	1	0.5%

Table 19: Factors incorporated in the enrollment models of the institution

	Public, 4-year	Public, 2-year
	n (%)	n (%)
Historic Enrollment Numbers	97 (76.4%)	50 (68.5%)
Historic Retention Numbers/Rates	91 (71.7%)	44 (60.3%)
Historic Graduation Numbers/Rates	71 (55.9%)	26 (35.6%)
Number of Admits	66 (52%)	21 (28.8%)
Number of Applicants	63 (49.6%)	26 (35.6%)
Number of Paid Admits (Deposits)	35 (27.6%)	3 (4.1%)
High School Enrollment Projections from the State	30 (23.6%)	26 (35.6%)
Student Demographics (e.g., Gender, ethnicity, etc.)	28 (22%)	19 (26%)
High School Enrollment Projections from WICHE	23 (18.1%)	5 (6.8%)
Population Growth Projections	22 (17.3%)	23 (31.5%)
New Orientation Reservations	22 (17.3%)	1 (1.4%)
FAFSA Filings	21 (16.5%)	11 (15.1%)
Housing Reservations	20 (15.7%)	1 (1.4%)
Demographic Changes in your Region	17 (13.4%)	18 (24.7%)
Test Scores (e.g., ACT, SAT)	17 (13.4%)	2 (2.7%)
Financial Aid Package	17 (13.4%)	2 (2.7%)
Historic Market Share	16 (12.6%)	11 (15.1%)
Scholarships Offers	15 (11.8%)	1 (1.4%)
Economic Factors (e.g., BLS Statistics, Unemployment statistics, etc.)	14 (11%)	22 (30.1%)
Effects of the Economy	14 (11%)	20 (27.4%)
Scholarship Amount	13 (10.2%)	2 (2.7%)
Number of Students Interactions (e.g., campus visits, information requests, etc.)	9 (7.1%)	1 (1.4%)
Number of Dismissal and Probation Students	8 (6.3%)	1 (1.4%)
Number of Cancelations after Deposit	8 (6.3%)	8 (11%)
Other	8 (6.3%)	9 (12.3%)
Number of Cancelations by Students	7 (5.5%)	1 (1.4%)

Number of Students with Signed or Intended Majors	5 (3.9%)	2 (2.7%)
Majors Available	5 (3.9%)	1 (1.4%)
Per Capita Income	4 (3.1%)	2 (2.7%)

[a.] Respondents could select all that apply

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