Systematic Literature Review of the Impact of State Budget Cuts on Public Higher Education Institutions in the U.S.

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Abstract

This study conducted a systematic review of the literature between 2000 and 2021 on the impacts of state budget cuts on public higher education institutions in the US. The inclusion criteria containing search terms 'State Budget cuts', 'Public Higher Education', or 'State Appropriations' in the titles, keywords, or abstracts in three databases, EBSCO, JSTOR, and Google Scholar, in the English language resulted in 1692 articles, N = 1692. Studies prior to 2000 were excluded, making N = 884. Considering studies that have either state appropriations or state financial aid as one of the independent variables resulted in the exclusion of 687 studies, N = 197. A skim-reading of the abstract and main body of the papers to consider experimental or quasi-experimental studies only resulted in the exclusion of 81 papers, N=116. Later, a critical appraisal tool was developed with a set of 10 questions to identify reliable studies that could answer the research questions. This excluded 99 papers, making N=17. Finally, an intrarater reliability test was conducted to demonstrate the reliability of the appraisal. This systematic review will be helpful in employing data analytics to better prepare policymakers and higher education administrators in the US for future budget uncertainties.

Keywords:

State Appropriations, Higher Education, Budget, Graduation Rate, and Public Institutions.

1. Introduction

This systematic literature review study was conducted to explain the significance of the problem with budget cuts to public higher education institutions in the United States (U.S.) along with some backdrop to the problem. After the recession in 2008, public higher education was one of the sectors that took huge cuts, and the states were not able to appropriate the funding back to earlier numbers. State funding per student has declined at public universities over the past few decades (Bound et al., 2019). Amid such budget cuts and negative economic impact on state budgets due to the COVID-19 pandemic, public higher education in the U.S. is going through turbulent times. Especially with limited resources due to inflation, economic slowdown, and competition for state funds from other sectors, public higher education has become a focus topic. Higher education funding and its impact on public institutions in a developed

country like the US could set an example to developing countries globally. When it comes to resource allocation, healthcare, primary and secondary education, and criminal justice was given more priority compared to higher education (Zhang et al., 2016)

The present study provides a review of the existing literature related to this research problem. A graphical flowchart showing the criteria for the systematic literature review has been presented, followed by a discourse on how state budget cuts impact public universities in the U.S. The review includes studies in the literature related to the effects of state appropriations or state financial aids. Although not done in this work, the idea is to employ data analytics to suggest predictive models in order to better prepare policymakers and higher education administrators for future budget uncertainties.

2. Application of Data Analytics

The twenty-first-century challenges of producing more educated citizens and skilled labor remain a problem due to the lack of state investments in public higher education institutions. There are very limited research studies that have conducted data analytics and quantified the effects of state budget cuts on public institutions in the United States. Using the latest information technologies, such as data analytics, along with machine learning algorithms could provide deeper insights into data to better prepare public institutions in the U.S. for future challenges. Especially after the COVID-19 pandemic, it became very important for higher education public institutions to analyze their historical data using the latest information technologies to prepare for future financial hurdles.

According to Johnson (2013), higher education institutions started using analytics to monitor student progress, recommend courses, predict student behavior, and predict student outcomes. He calls those techniques and methods of extracting data 'academic analytics'. The use of data technologies in higher education institutions could show unseen data relationships. Technology management plays a crucial role in promoting technologies such as data analytics to improve decision-making and face complex situations. Hoseini et al. (2021) presented a review of the application of machine learning and data analytics in quality issues in service, manufacturing, food, software and information technology, healthcare, and health insurance industries. Their study highlighted the importance of data analytics and data science to study vast amounts of datasets generated because of advancements in the technology field. Hoseini (2020) applied machine learning and data analytics to find fraud in Medicaid claims. He adopted machine learning algorithms and data analytical methods to predict fraudulent claims.

Data analytics could be used for operational efficiency in a variety of fields. It could help organizations make profits and allow companies to identify potential problems and eliminate them. A study conducted by Anggrahini et al. (2021) used data analytics to obtain insights into supplier relationship management at a large-scale manufacturing company. The study helped the manufacturing company assess supplier performance and responsiveness to produce high-quality products. The data analytical models and analysis helped the manufacturing company in strategic decision-making. Data analytics could benefit various industries: higher education, healthcare, supply chain, manufacturing, automotive, information technology, retail, banking and finance, construction, communications and entertainment, construction, energy, and many more. For example, a study by Summerfield et al. (2018) showed that it could predict project management success by creating analytical models that could provide insights on crucial predictors such as cost overruns, overscheduling, employee utilization, and expected end date. Another study conducted by Parimi and Babu (2020) to explore and analyze various software security vulnerabilities at a large information technology enterprise in the cybersecurity domain observed a correlation between security levels and vulnerability scores.

As mentioned in the introduction section, this paper is about a systematic review of studies in the literature related to the impacts of state budget appropriations and financial aid on higher education. This review is a part of the ongoing research with a final objective of data analytical models in order to better prepare for future budget uncertainties.

3. Systematic Literature Review Methodology

The authors of this study systematically reviewed the related literature to assess the existing knowledge and gaps related to state budget cuts and their impact on public higher education institutions in the U.S. The methodology is similar to the one employed in Al-Odeh et al. (2021). Table 1 summarizes the inclusion and exclusion criteria of the review and the methodology for this review was based on a graphical flowchart shown in Fig. 1.

State budget to public education institutions comes in two forms: appropriations to institutions and financial aids to students. In this research study, we focused on articles that studied the effects of state appropriations on public

institutions and student outcomes or the effects of state financial aids on college enrollment and completion. In other words, the primary focus was on articles that have had state appropriations or state financial aids as their independent variables. The inclusion criteria with search terms 'State Budget cuts', 'Public Higher Education', or 'State Appropriations' in the titles, keywords, or abstracts in three databases EBSCO, JSTOR, and Google Scholar in the English language resulted in a total of 1692 articles, i.e., N = 1692. The three databases: EBSCO, JSTOR, and Google Scholar, generally index all publications, including anything indexed in SCOPUS and Web of Science. Hence, other databases such as SCOPUS and Web of Science were not searched. This research study was filtered to have only studies that were published in 2000 or later, which resulted in the exclusion of 808 papers, N = 884. Later, this research study searched for studies that have either state appropriation or state financial aid as one of the independent variables, and that resulted in the exclusion of 687 studies, N =197. The researchers performed a skim-reading of the abstract and main body of the papers to find only experimental or quasi-experimental studies, which resulted in the exclusion of 81 papers (N=116). After 116 studies were identified, a critical appraisal tool was developed, as shown in Table 2, with a set of 10 questions to identify reliable studies that could answer the research questions pertaining to the present study. The critical appraisal tool identified studies closely related to state budget cuts to public higher education in the US, excluding 99 papers, making N=17. Finally, an intrarater reliability test (kappa coefficient) was conducted to demonstrate the reliability of the appraisal.

Table 1. Literature study selection with inclusion and exclusion criteria from the EBSCO, JSTOR, and Google Scholar databases.

CRITERIA	DECISION
Search terms included ‘State Budget Cuts’, ‘Public Higher Education’, or ‘State Appropriations’ in the titles, keywords, or abstracts.	Inclusion
Papers are written in the English language.	Inclusion
Studies conducted outside of the United States	Exclusion
Consider studies published between 2000-2021 and exclude prior studies.	Exclusion
Studies that do not have independent variables of State Appropriations or State Financial Aid?	Exclusion
Articles that are not experimental or quasi-experimental research	Exclusion
Appraisal of articles related to the research questions was conducted, and articles were screened based on the critical appraisal tool.	Exclusion
Number of papers that are included in final study N = 17	

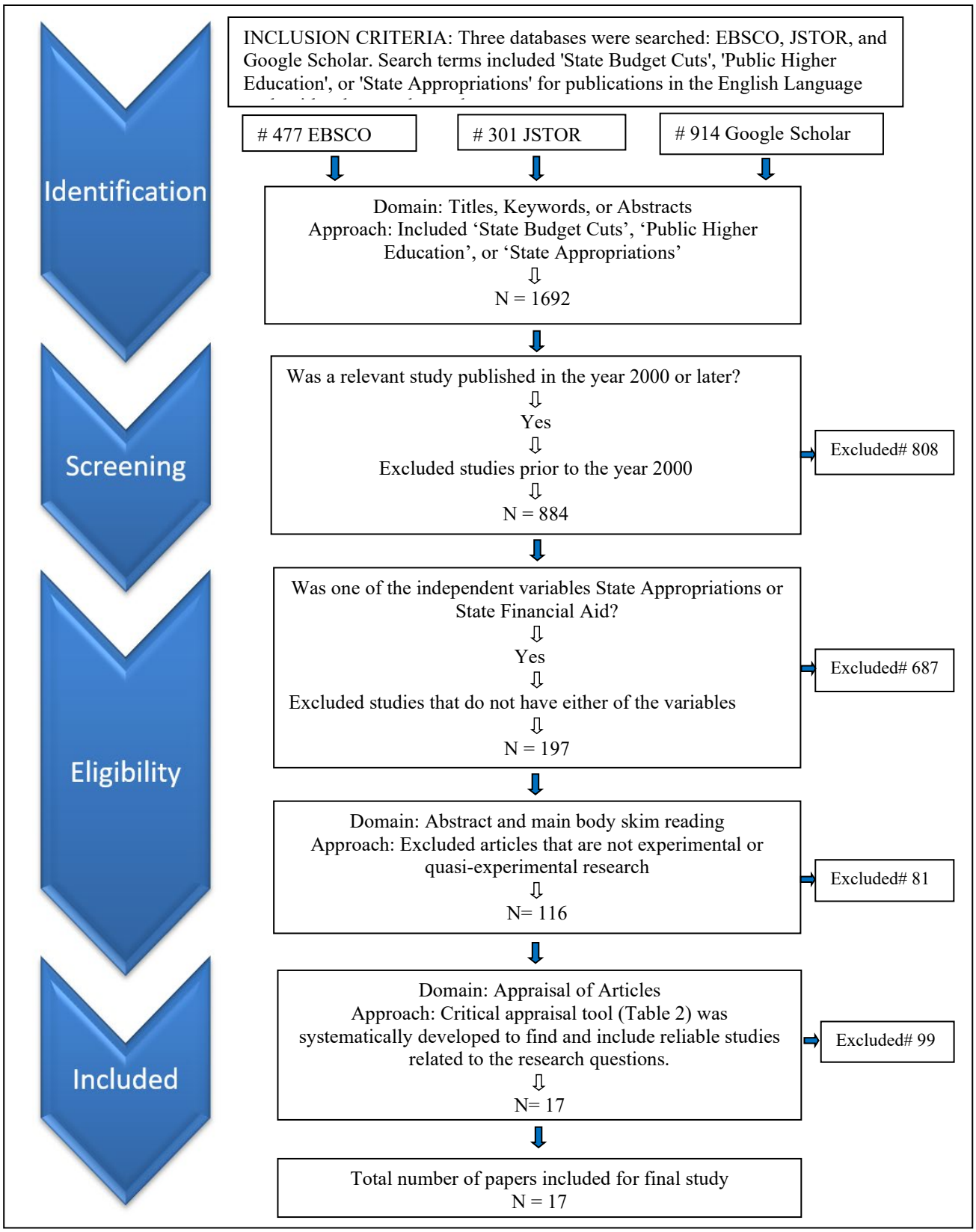

Figure 1. Systematic Literature Review Graphical Flowchart

The appraisal of articles was conducted for 116 articles to answer the research questions that allowed the researchers to identify reliable, methodologically appropriate, and unbiased research studies. The quality of the study could be analytically evaluated using critical appraisal tools, and they help minimize biases in a research study (Katrak et al., 2004). The researchers could not find a critical appraisal tool specific to this research; hence, the researcher developed it, as shown in Table 2. The articles were divided based on the research design, and the details are shown in Table 3. Additionally, the total number of articles is presented as a bar chart based on the year of publication, which can be seen in Figure 2. From a total of 116 research studies, 17 articles that were closely related to state budget cuts to public higher education institutions in the US were included for final review after conducting an appraisal using the critical appraisal tool from Table 2. Hence, the studies included for final review N=17.

Table 2. Critical Appraisal Tool

		Yes	No	Unclear	Not applicable
1.	Were the research questions and method clearly stated?	□	□	□	□
2.	Was the need for the research study adequately established?	□	□	□	□
3.	Were the statistical analysis methods described in detail?	□	□	□	□
4.	Was the study design appropriate for the research question? *Note: Appropriate study design explains clearly how to collect, analyze, and interpret data to provide an answer to the question.*	□	□	□	□
5.	Was the study limited to only public higher education institutions?	□	□	□	□
6.	Was the data collected and used for analysis address the research question?	□	□	□	□
7.	Was appropriate statistical analysis used for the study? *Note: Appropriate statistical analyses are studies that are linear, ordinal, or multinomial regressions.*	□	□	□	□
8.	Was the data extracted from reliable sources? *Note: Reliable sources are institutions that are approved by the U.S. Department of Education to publish postsecondary data.*	□	□	□	□
9.	Were multiple variables used in the analyses of the research study?	□	□	□	□
10.	Were specific directions for new research initiatives proposed?	□	□	□	□

Table 3. Research design and number of studies in each design

Research Design	Count of Research Design
Difference-in-differences	47
Regression Discontinuity	36
Randomized Control Trial	8
Difference-in-differences, Regression Discontinuity	6
Instrumental variables estimation	6
Fixed effects panel model	5
Event History Analysis	3
Instrumental Variables	2
Dynamic fixed effects panel model	1
Two-way Fixed Effects	1
Instrumental variables estimation & Fixed effects panel model	1
Grand Total	**116**

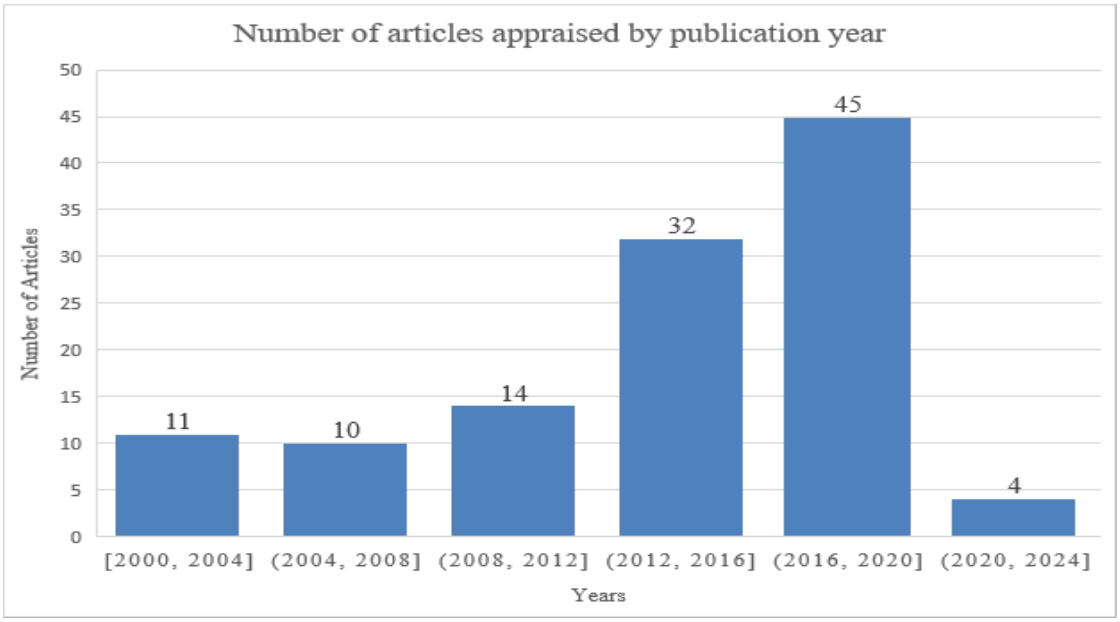

Figure 2. Number of articles appraised by publication year

3.1 Intrarater reliability test (Cohen's kappa coefficient)

An intrarater reliability test (Cohen's kappa coefficient - κ) was calculated with a gap of three weeks to determine if there was an agreement between 'article appraisal time 1' and 'article appraisal time 2'. The score could range from -1 to +1. The calculation of Cohen's kappa test (κ) resulted in a score of 0.849, which means there was an 85% measure of agreement between appraisal study from time 1 and time 2. The interrater reliability (κ) test score suggests that there was a very significant strength of agreement between 'time 1' and 'time 2'.

4. Results of the Review and Discussion

4.1 State Appropriations: Effects on tuition, institutional expenditure, research activity, enrollment, and graduation rates

According to Delaney and Doyle (2011), state appropriations at public higher education institutions have been decreasing significantly compared with other budget categories for the past two decades. Public institutions, in response, either increase tuition or decrease institutional expenditure when state appropriations decline. A Delta Cost Project for a data set from academic years 2000 to 2010 conducted to examine the impact of declining state appropriations on domestic students (In-state tuition) showed that a 10% reduction in state appropriations resulted in a 1.1% increase in tuition and fees and a 0.7% increase in the total yearly cost of college education (Goodman and Volz 2020). According to Webber (2017), an additional $257 of tuition and fees on average was required for a $1000 reduction in state appropriations per FTE student. He also mentions that most public institutions greatly rely on tuition revenue to avoid disruption to their core functions when there are state budget cuts.

With each recession since 1980, the state support per FTE student has declined at a greater rate, and recovery has become slower. In 2001, public institutions enrolled 8.7 million students, and per FTE, students received $9,547 as general operating expenditure. However, in 2019, public institutions were only provided $7,388 per FTE student for a total of 10.9 million enrolled students (SHEEO, 2021). Institutions respond to these changes by making changes to their spending categories. The most affected categories are academic support, student services, and instructional spending (Deming and Walters 2018). As per the study conducted by Frye (2015), declining state funding has shown a negative impact on the academic workforce at public institutions. A regression model conducted using IPEDS data from 1994 to 2013 has shown that when there are state budget cuts, public higher education institutions respond by decreasing the number of tenure track faculty and increasing part-time faculty. For every 10% decrease in the state, appropriations resulted in a 0.23% increase in part-time faculty. Husted and Kenny's (2018) study provided evidence that state appropriations could also negatively impact public research universities in conducting research activities. Their analysis taking 152 public universities showed a positive relationship between state appropriations and research productivity. A reduction of 10% of state appropriations reduces 8.4% of patents awarded.

A study conducted by Goodman and Voltz (2020) found that a 10% decrease in state appropriations resulted in a 3% decrease in enrollments at public institutions. The IPEDS enrollment data from 1900 to 2013 found that there was a positive relationship between the increase of state budget to public institutions on current and future student enrollments. These studies present an issue that might arise due to declining state appropriations; that is, they may enroll less underrepresented students, as they may not have the ability to pay most tuition (Jaquette and Curs 2015).
Previous studies find significant evidence on the impact of state budget cuts on student outcomes. The student outcomes are a combination of graduation rates and the number of credentials awarded. Zhang (2009) conducted a research study to find a correlation between graduation rates at public four-year institutions and state appropriations. He found that a 10% increase in state appropriation per FTE resulted in a 0.75% increase in graduation rates, and simultaneously, a 10% decrease in state funding resulted in a 0.56% decrease in graduation rates.

4.2 State Financial Aid: Effects on college enrollment, college persistence, and college completion

Postsecondary investments made by students towards higher education became a concern as state support was declining steadily (Chakrabarti, 2019). There was no significant evidence suggesting that state financial aid influences overall college enrollment. It only helped students attend more costly universities where they could receive aid, and financial aid packages that are less than realized packages significantly impact a student's likelihood of enrolling (SHEEO 2021). However, the effects of financial aid, state educational appropriations, student tuition cost, and institutional expenditure on persistence to stay in college are evident. Most studies have suggested that financial aid helps students graduate at higher rates than nonaided students. In summary, a decrease in state educational appropriations results in an increase in tuition rates at public four-year institutions and enrolls more out-of-state and international students. It also negatively impacts expenditures on instruction, academic support, and student services

at these institutions. There was a concern with a decrease in in-state undergraduate students enrolled at public institutions and, finally, a decrease in degrees and certificates awarded. Another study finds that funding to students in the form of financial aid was highly positively correlated with college enrollment (Deming and Walters 2017). According to Shin (2010), U.S. institutions did not experience much change in their institutional performance by adapting to a performance-based funding model. The performance-based funding model is a model that proposes more funding to institutions that have higher graduation rates. According to Monarrez et al. (2021), state spending decisions related to state financial aid programs have a great impact on public institutions. If public institutions' funds are cut by the states, then it results in a decline in enrollment and the number of degrees awarded. A study conducted to identify the causal effect of financial aid on students' persistence towards degree attainment showed a positive correlation if the aid is awarded as a need-based aid (Alon 2011).

Anderson and Zaber (2021) studied the potential effects of financial aid on students and their decision to enroll in college. Their study shows that most students are enrolled in a college by the time they apply for financial aid, and they are at a point in deciding whether they should keep going forward and pay for college or not. Students entering college for the first time find it hard to see or predict what it takes to complete a college degree until they receive financial aid (Deming and Dynarski 2010).

Despite concerns expressed by policymakers and scholars that the declines in state support have reduced the return to education investment for public sector students, little evidence exists that can identify the causal effect of these funds on long-run student outcomes.

5. Conclusion

This study focused on the review of the impact of state budget cuts in terms of appropriations and financial aid on public higher education institutions in the U.S. This research developed a tool for the appraisal of articles. Further, an intrarater reliability test was performed to check the reliability of the appraisal. The systematic literature review of the articles published in 2000 or later yielded 17 articles finally. These articles reveal that although financial aid reduction has not shown any significant effect, cuts in state appropriations have increased tuition fees, the total cost of education, and part-time faculty; and decreased the number of patents awarded and student graduation rate at public institutions. The results of this study will serve as a foundation to understand how past studies were conducted to quantify the effects of state budget cuts on various variables at public higher education institutions. This will also prepare and provide a direction to all stakeholders at public institutions to face the budget cuts as an aftermath of the ongoing COVID-19 pandemic.

The existing literature has not focused on using the latest information technologies, such as data analytics and machine learning, to study publicly available higher education data to understand the impact of state budget cuts. Hence, the next objective of our research is to use data analytics to come up with models that can be used to better deal with future budget uncertainties.

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